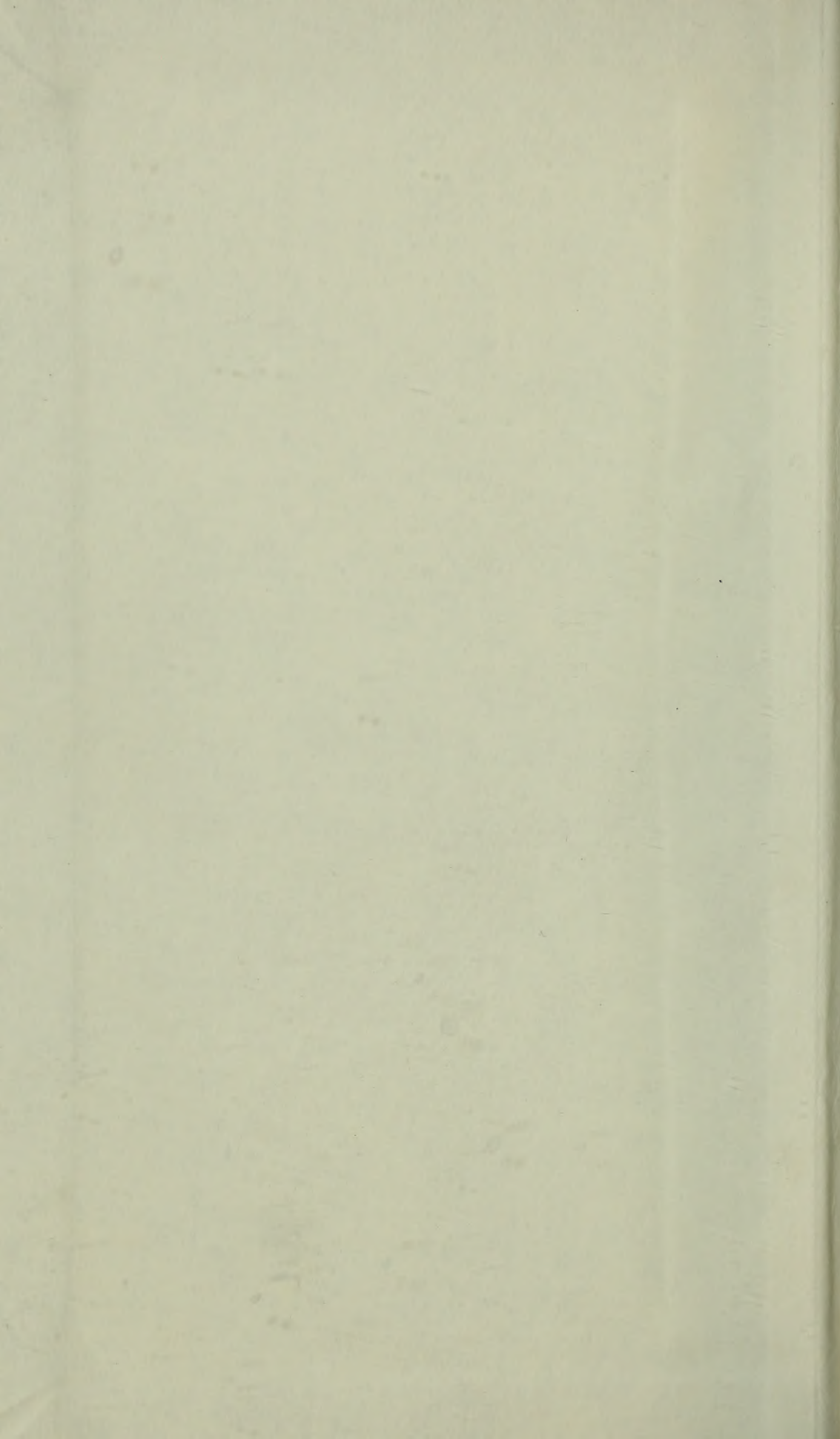


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THE
HORSE-HOEING HUSBANDRY:

OR,

A TREATISE on the Principles of TILLAGE and VEGETATION,
wherein is taught a Method of introducing a sort of VINEYARD
CULTURE into the CORN-FIELDS, in order to increase their
Product and diminish the Common Expense.

BY JETHRO TULL,
OF SHALBORNE, IN THE COUNTY OF BERKS.

TO WHICH IS PREFIXED,
An INTRODUCTION, explanatory of some Circumstances connected
with the History and Division of the Work; and containing an
Account of certain Experiments of recent date,

BY WILLIAM COBBETT.

LONDON:
PUBLISHED BY WILLIAM COBBETT, 183, FLEET-STREET.

1829.

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WHEREIN IS TAUGHT A METHOD OF INCREASING A SOIL OF VINEYARD
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INTRODUCTION,

BY MR. COBBETT.

THERE are some circumstances, connected with the history and division of the work of Mr. TULL, which it will be necessary for me to explain; and I think it may be useful to speak of some *experiments*, of recent date, which have been made by myself and others, and which were made in consequence of reading the work here presented to the public.

As to the former, the work was written and published by Mr. TULL in several distinct pieces, and at several different times. He never published a new and complete edition, in one volume; but, took the several parts, bound them up in one volume, and, in each part or pamphlet, made continual references to what had been published before. As the years passed away, and as his experience taught him, he altered his opinions, and, of course, his method of proceeding.

The publication of the *nineteen Chapters* of his work were, in some years afterwards, followed by a mass of *Notes*, nearly, if not quite, equal in bulk to the Chapters themselves. So necessary was it, that these should be read *along* with the Chapters, that he gave a particular direction at the head of this

collection of Notes, that the reader should, *before he read the Chapters*, go over the Notes, see what page, line, and sentence each referred to; then *mark with a pen*, in the Chapters, the places at which the Notes were to come in; and then begin to read the work, and to be sure to *read in* the Notes. In short, this collection of Notes was to *make part* of the Chapters, and they were written in a way to be brought into their several places, and there make part of the Chapters themselves, which, indeed, were altogether imperfect without them.

This being the case, I have, in this edition, done what the author would have done, if he had lived to send a new edition to the press. I have brought all these Notes, or parts of Text subsequently written, and have introduced them into the text at their proper places; which will be found to be a very useful typographical improvement. Notes are always disagreeable. They are always to be avoided if possible; but a book, half text and half notes, the former incomplete, and even erroneous, without the latter, was an inconvenient thing indeed; and such as it was absolutely necessary to get rid of. Some editors of TULL of about forty years ago, have gone a short way indeed to work: they have wholly omitted this body of Notes; or, rather, in the author's view of the matter, this large part of the text; and have, thus, presented to the reader a thing which is really not the work of TULL.

The introducing of these Notes, in the manner just described, produces, here and there, a sort of disjointedness in the matter. For, though the author was writing parts to *come in*, his connecting phrases are not, everywhere, so naturally applicable as they might have been. This, however, is merely an awkwardness of manner, and that only in a very few instances ; and, in no instance, has it the smallest tendency to mar the meaning.

One part of the work of Mr. TULL treats of the making and the using of *drills* and *ploughs* and *horse-hoes*. He was the *inventor* of the *first drill*. Of course, he has numerous and very particular and minute written descriptions and instructions relative to the mechanical matters, besides a great number of engravings. These, though matter of *curiosity*, can be of *no use* now-a-days, when the making and using of instruments of this sort are brought to such perfection ; and, as it was an *useful*, and not a *curious*, book that I was desirous to present to the public, I have, agreeably to my Prospectus, wholly omitted this part of the work. The reader will, however, find now and then a passage, in which this omitted part of the work *is referred* to ; but, as he will have had a knowledge of the ploughs and drills of the present day, this circumstance cannot be productive of any misconception or inconvenience.

The author was a *Lawyer*, and his having learned the *Latin language*, induced him, like most

others who have been taught what they call “the *learned* languages,” to use the Latin, and sometimes the Greek, words, when quoting from *Virgil* and others. I have thought it best to retain the words, thus used, in those languages. They are, in general, translated by the author; and, in the few cases where they are not, no inconvenience can arise from the omission. The Chapter on the *Virgilian Husbandry* is very curious. In it we clearly see, that we have all our old agricultural notions and practice from the *Romans*; and, whoever has observed much of the agriculture in France, will know, that, there, the Husbandry is, to this day, very nearly the same that it was in Italy in the time of *Virgil*.

Besides the mass of Notes, before-mentioned, there was an *Addition*, which the author calls an *Addenda* to his Husbandry. This was a very important part; and it has, therefore, been put in its proper place.

Last of all came “*Notes on the Preface*,” which are here, as in the author’s collection, placed after the work. They are very necessary to be *read*, relating, as they do, to many essential matters, omitted in the Preface; and, especially as they speak of a *Society of Writers*, who were *anonymous*, and whom, therefore, as well as on account of the doctrine of *equivocal generation of plants*, which they held, he calls “the *Equivocal Society*,” and, sometimes, for brevity’s sake, “*Equivocus*.” This

Society published, it appears, a periodical work on Agriculture ; and, it also appears, that they contended against the doctrines of Mr. TULL, and treated him with great severity and brutality. They were, in their day, in Agriculture, what the greater part of our *Reviewers* now are in Politics. They had *no names*, any more than our critical sages have ; and, it is not improbable, that some future editor of Cobbett's *Essays on Paper-Money*, may have to perform for the *Edinburgh* and *Quarterly* conjurers the office which I am now performing for TULL's "Equivocal Society," who and whose works are now, what *Walter* and *Stoddart* and *Old Times* and *New Times* will be fifty or sixty years hence ; that is to say, wholly unremembered except in the pages of those works, which they have vainly endeavoured to suppress by their calumnies on the authors.

It appears to me, that, after the *Author's Preface*, the Notes to the Preface ought to be read ; for though, being written after the work, they allude and refer to many things rather out of place ; still, these Notes are necessary to give the reader a fair view of the Author's *situation* at the time of writing the work, and of his *objects* in writing it : and we never enter on the reading of a work with so much advantage as when we are thus prepared.

As to the recent *experiments*, of which I am

about to speak, it should be observed here, generally, that it is the *principles* of Mr. TULL, and not the whole of his particular practice, that the scientific farmer and gardener will turn to account. Mr. TULL's main principle is this, that *Tillage will supply the place of manure*; and his own experience shows, that, *a good* crop of wheat, for any number of years, may be grown, every year, upon the same land, without any manure, from first to last. The recent experiments that I have to mention confirm this; but, there is a difficulty in the case of *wheat*, mentioned by Mr. TULL himself, and which my experience also confirms.

It is naturally asked: "If perpetual crops of wheat can be produced on the same land without manure, *why is it not done?*" The answer to this question will be found in the following account of experiments.

Experiment in *Spring-wheat*, in 1813.—On the 5th of April I sowed a land *broad-cast*, all across a field, which land contained thirteen *rod* or *perch* of ground. The land was in a very good state and very suitable to the crop. On each side of this land, and close to it, were made three ridges across the field at three feet asunder; and on these ridges was sown wheat, of the same sort, in a single drill, or row, upon the top of each ridge. So that there were two thirteen rods of this Tullian wheat. The broad cast wheat was weeded and

kept in very good order; and the Tullian was very nicely ploughed between and kept clear from weeds in the rows themselves.

Many persons saw this wheat while growing; and though all were struck with the superior strength of straw and length and size of ear in the Tullian wheat, it appeared to every one impossible that a land, nine feed wide, having only *three rows* of wheat on it, should bear as much as a like quantity of land *covered all over with wheat-plants*. One of the gentlemen who saw the wheat, while growing, was Mr. MISSING, the Barrister, of Posbrook, about seven miles from Botley. In order to "*try the question*," as the lawyers call it, he and I made a bet as to comparative quantity; he on the broad-cast, and I upon the three rows.

The whole was reaped on the 16th of August, and housed on the 20th of the same month. In a little while after, it was, in presence of Mr. MISSING, thrashed out; the broad-cast by itself, and the two sets of three rows together. The two parcels were then winnowed. Then the 'Tullian parcel was divided into two; and the result was as follows:—

	bushels.	gallons.
Clean wheat on Thirteen Perches, in the Tullian manner, single rows on three-foot ridges }	2	5 $\frac{3}{4}$
Clean Wheat on Thirteen perches, Broad-cast. . . .	2	7 $\frac{1}{2}$

The first was at the rate of 33 bushels 6 gallons to the acre; the latter at the rate of 36 bushels half a gallon to the acre. I proposed, that, in

estimating the crop, we should take the *seed* into view, and that my side should have *added* to it a quantity equal to the difference in the quantity of seed that the broad-cast had demanded *more* than the Tullian. And, though my antagonist was by no means prepared to admit of any such interpretation of the terms of the bet, the reader will see, that, in estimating the clear relative produce, the *seed* must be taken into view. Now, then, the broad-cast was sown at the rate of three bushels to the acre; the Tullian at the rate of five gallons to the acre. The accounts, therefore, stand thus:

		bushels.	gallons.
BROAD-CAST.	Produce	36	$0\frac{1}{2}$
	Deduct Seed	3	0
	Clear Crop	33	$0\frac{1}{2}$
TULLIAN.....	Produce	33	6
	Deduct Seed	0	5
	Clear Crop....	33	1

Thus, then, the clear produce is rather greater in the Tullian than in the other.

Besides this experiment, I made another upon a part of one of the rows. I took ten feet in length of one of the rows, and thinned out the plants so as to leave only twelve plants in a foot in length. The produce of these ten feet was $1\frac{1}{2}$ pint within a mere trifle; and it weighed 1 lb. 5 oz. avoirdupois. Another ten feet, adjoining the for-

mer ten feet, but *not thinned out*, produced *not so much* by a wine-glass full; but it *weighed* precisely the same, owing to the *unripeness* of the former, some of the ears of which were *quite green* when cut. Now observe; this thinned wheat, which would not require more than about *a gallon and a quarter* of seed to an acre, produced at the rate of thirty-one bushels and nearly a half to the acre; and the wheat (*Spring* wheat too) weighed at the rate of 56 lbs. to the Winchester bushel. The weight of the *straw*, when thrashed, on the ten feet, was 2 lbs. 7 oz. and, on an acre, it would have been 1 ton 11 cwt., 2 qrs. and 21 lbs.

It must be observed, however, that the year 1813 was the finest year for wheat within the memory of man. If the summer had been *cold*, and the harvest *backward*, the result, in the above case, would have been very different. The reader will note well what I have said about the *unripeness* of the ears on the ten feet of thinned wheat. Here the wheat was *backwarder* than in the rest of the rows which were *not thinned*; and, throughout the whole of the rows, the wheat was *backwarder* than in the broad-cast. This is the obstacle, and the only obstacle, to growing Tullian wheat. The tillage makes the plants keep on growing to a much *later period* than when they stand thickly all over the ground, and have no tillage while growing. This *late growth*, and the *juiciness* of the stalks and leaves, expose the plants to that sort of *blight*,

which makes the straw *speckled*, and sometimes gives it a *dark hue* all over. And whenever this blight lays hold, the *grain is thin* and light. The Tullian grains are much *larger* than those of the broad-cast; but, if the blight lay hold, they are *not so heavy*, nor any thing like it. In *hot* countries, where this blight is unknown, the Tullian wheat would always exceed the broad-cast; but, in this chilly and backward climate, you must, on an average of years, expect this blight, unless you sow *very early*. This I found to be the case. My land did not permit me to sow early; and, though I had, in 1814, on a five-acre field, *four quarters to the acre* of white Essex wheat, sown on *four feet* ridges, a single row upon a ridge, I found so much blight generally, that I was obliged to discontinue the system, as to wheat, though, with regard to Swedish Turnips (I never raised any other) I found it so excellent.

If you can sow your wheat in *August*, five times out of six you may escape the blight in the straw. But even then you must not sow too *thin*; always bearing in mind, that the thinner the plants stand, the *later* the wheat is in getting ripe; and the greater the chance of blight. It is to be observed that Mr. TULL's was a *high-country* farm. I went to see it last fall. It is on a bottom of chalk. It is *Saint-Foin* land. The sowing always takes place *early*; and this by no means applies

to low, deep, rich, or stiff lands ; though, we are now about to see that the system, even as to wheat, *may* be applied to strong lands.

When in Herefordshire, last fall, I heard of a gentleman, Mr. BEAMAN, who had, for many years, raised wheat in the Tullian manner. I had not time to wait on that gentleman myself ; but, I put on paper certain questions, which I requested Mr. PALMER, of Bollitree Castle, to put to Mr. BEAMAN, and then to send the questions back to me, together with the answers. This was done by Mr. PALMER, in the following words :

How many years has Mr. Beaman grown Tullian wheat upon any one field, without the intervention of other crops ?—Ans. *Six Years.*

Has he manured for it ?—Ans. *No.*

What has been the width of the ridges ?—Ans. *Began at twenty-seven inches, then four feet and a half, and, lastly, six feet.*

What have been the number of rows on each ridge ?—Ans. *One row on twenty-seven inches, two rows on four feet and a half, and three rows on six feet.*

What is the season of sowing ?—Ans. *The earlier the better ; should be up before Michaelmas.*

How many ploughings, and the seasons of the ploughings ?—Ans. *The oftener the better ; cannot plough too much, nor too near at the first ploughings.*

What is the quantity of seed to an acre ?—Ans.

From half a peck to two bushels ; but this must depend upon the soil, and upon the season of drilling.

What is the expense of the hand-hoeings?—

Ans. *From eighteen-pence to two shillings an acre.*

What is the general amount of the crops?—Ans.

Twenty-three bushels to an acre.

Does it blight more than other wheat?—Ans.

Thinks it does.

Please to get samples of as many years as possible.—*The samples got are of the years 1820 and 1821.—N.B. Very good wheat. I guess it to weigh 57 lbs. or 58 lbs. a bushel.*

What sort or sorts of wheat has he drilled?—

Ans. *Has drilled all sorts ; prefers a short stiff straw.*

What is the quantity of straw?—Ans. *About a load and a half to an acre.*

To the above Mr. PALMER added, that Mr. BEAMAN calls his land, “*a marly clay.*” “The top-soil,” says Mr. Palmer, “is a stiff, dark-coloured loam, upon a marl and clay bottom.” Mr. BEAMAN thinks a single plant in about three inches would grow the greatest crop of wheat ; but, then, the wheat should *be up in August.*

I am very much pleased with this information from Mr. BEAMAN ; because *there is the thing now to be seen !* Mr. TULL continued his wheat crops to the harvesting of the *twelfth* upon the same land without manure ; and, when he *concluded* his work, he had, as he informs us in a Memorandum, the

thirteenth crop coming on, likely to be very good. Mr. BEAMAN had had *six crops*, and the average of his crops had been *twenty-three bushels to the acre*, which is more than Arthur Young allows as the average of the kingdom. However, is there any farmer in England (no matter what his land may be) who would not be glad to get twenty-three bushels of wheat from an acre, year after year, *without manure* and with so little expense as that of four or five horse-hoeings and two shillings an acre hand-hoeing? The blight is the only obstacle; but, perhaps, Lammas wheat sown *in August*, or spring (bearded) wheat sown *early in March*, would, five times out of six, escape the blight; and, unquestionably, a field of Tullian wheat in ear, with the ridges straight and the land clean, is the most beautiful thing in the vegetable world. It is not *grand* like the Indian corn; but it is even more beautiful than that. After three or four crops, there is very little trouble from *weeds* or *grass*. The land is prepared for any crop; and it is bearing a good crop, while the preparation is going on.

Besides the *early sowing*, care must be taken not to sow *too thin*. By thick sowing along the drills, you get the plants to stave one another a little, and the wheat ripens at an *earlier period*. Mr. TULL, in his Memorandum, says, that he put *one row* on a ridge in part of a field, the last year of his farming; but missed ascertaining the effect,

owing to his being ill, and to the hurry of the harvest. I am inclined to think, that it would not have answered; for the fault always is, that the *plants keep on growing to too late a season*; and the nearer you go to them with the plough, the more *gross* they will be, and the later they will continue to grow. And, we see, that Mr. BEAMAN began with *one row* on a ridge; but that he has now come to *three rows*.

This grossness produced by the tillage does, however, fully show the truth of the *grand principle* of TULL; namely, that *tillage*, and tillage alone, will create and supply the *food of plants*, and will, in many cases, *render manure wholly unnecessary*. In divers cases the Tullian wheat culture may be of use; but it is in the cultivation of cattle-food crops that its great excellence is found. The *effects* of the tillage while these crops are growing, we can all see plainly enough by looking at the crops themselves; and by the work before us we are taught the *causes* of those effects. It is not the mere *putting of plants in rows* that was taught by Mr. TULL; but the *reasons* for doing this; and, in the stating of those reasons, he has developed all the great principles of vegetation. He was, indeed, the inventor of the first *drilling machine*; but that which entitles him to our admiration and gratitude, is, that he discovered and explained to us the *reasons for inventing that first drilling machine*.

It is impossible for any man of just sentiment to read the work of Mr. TULL without feeling a strong desire to show some mark of high respect to the memory of the Author; what then ought our indignation to be at seeing him pillaged and plundered by whole bands of writers on what they call "*the Drill Husbandry*," who never so much as mention his name, and who have, perhaps, purloined from one another, till they themselves would be unable to guess, who, in any one instance, was the original thief. One thing, however, they take special care of; and that is, so to disfigure, to mar, to confuse, and to confound his matter, that he must be a clever man indeed who is able to make top or tail of what they write and publish.

It is curious enough, that he was, even in his own time, an object, at once, of *plunder* and of *calumny*. He says, in the Memorandum, in which he takes his farewell of the public, "Some have told me, that the whole Treatise should have been entitled, Husbandry Mathematically Explained; others, *Agricultura Tulliana*: and this last is the title generally now given it in Ireland. It is said that mine is the first book of Agriculture that has happened to be *pirated*; and that upon the first notice of it, I ought to have *desisted*; because I must be a loser by proceeding any further at the press; and that *I could have little obligation to a country whose laws did not*

“ *protect me in the property of my labour* (which
“ was the original foundation of property in most
“ things) and of my expense that is joined with it.
“ The best apology I can make for this my folly
“ is, that it is natural for the true parent rather
“ to lose the property of his offspring, than not to
“ endeavour to *preserve the life and well-being of*
“ *it, though in the hands of enemies.*”

Would this apt and beautiful allusion to the story of the true and the false mother, who brought their dispute before SOLOMON, have any *effect* on the pirates to whose baseness Mr. TULL here alludes? Not it indeed; except to induce them to add abuse of the author to the stealing of his property. However, it is *the laws*, as he so well observes, the *injustice* of which, the matchless injustice of which, exposed him, as they still expose every other man of talent, to the plunderings of these villians. Certainly a man is under little obligation to a country whose laws do not protect him in the *propriatorship of his labour*. See with what care the proprietorship of lands, of tithes, of manorial rights, is fenced round! You may not *set your foot* upon another man's land without paying for damage to some amount; and you may not do it a second time without heavy punishment, bodily or pecuniary. Nay, look at the laws to preserve wild animals for the *sport* of the landholders; and, when you have looked at them well, when you have examined into all their *pains* and *penalties*;

turn and see the protection which has been provided for the property which a man has in a book which is a thing of his own creation, the fruit of his own skill and genius, the result, perhaps, of years and years of labour, and, possibly, the only provision he may have to leave for a helpless family! When you see laws like these: such laws to protect the authors of books; and such laws to preserve partridges, pheasants, and hares; no questions are necessary; you know, at once, by whom the laws have been made.

I have derived so much pleasure, and so much real advantage from the reading of this work, that I cannot help wishing to see it in the hands of others. I was born and bred amongst affairs of gardening and farming. I had read a great deal too about them; but, till I read TULL, I knew nothing of the *principles*. But what struck me most forcibly, when I came to read TULL, was, that all that I had read before, that had any thing like principle in it, had been stolen from him; shockingly disfigured indeed; but still, whatever there was of good was his. Here are, in fact, all the whole code of principles of vegetation. They apply in all cases. Whether in the corn-fields, the pastures, the gardens, the coppices, the woods, or the forests. The work does not treat of the detail of *planting trees*, for instance; but, when you have read it, you will *never plant a tree badly*. You will take care, that the earth shall be *finely broken*; that it *lie close to*

the roots ; and that it be not tumbled into the hole in clods. Mr. TULL does not treat of *transplanting* field plants at all ; and he (who wrote when *Swedish Turnips* had not yet been heard of in England) says, that transplanting is not so good a way as sowing in rows and horse-hoeing. But it was from reading TULL that I came to take, by preference, *dry weather* to transplant in, and not the *showery weather*, chosen for that work by all the writers, French as well as English. TULL had taught me, that it was *finely broken earth* that I ought to have about the roots of my transplanted plants. This I could not have if I transplanted in the *wet*. The instructions, on this head, given in my *Year's Residence*, a seedsman in London told me contained the most *valuable discovery* that he had met with in any book. It certainly is valuable ; but though I had had instances of the *effect*, I never knew the cause, and never should have attempted the thing on an extensive scale, had I not read TULL.

If there were no other motive for re-publishing this work than that of doing the Author *justice*, that ought to be motive sufficient. He has been plundered by *English* writers not a few, and by *Scotch* in whole bandittis. I wonder they are not ashamed of pillagings so flagrant ; but when once a man can bring himself to do such things, he has little shame left. Mr. *John Christian Curwen*, who has won so many *Agricultural prizes*, has an ac-

count of the *effects of ploughing between cabbages and between potatoes*. These experiments he *takes to himself*. He has an experiment proving that *moving the ground in dry weather makes it moist*. This discovery he ascribes to BISHOP WATSON! What a pretty fellow this Bishop must have been, if he pretended to be the *discoverer* of this! As to the effects of ploughing between cabbages and potatoes, there were, indeed, no cabbages in the *fields* in TULL's time; but he describes the effect of *digging* between them; and as to Mr. CURWEN's potatoes, the experiment, in all its detail of operations, is almost literally from TULL! Let any man look into the Chapter of TULL, *On Hoeing*, towards the close. Then turn to Curwen's *Hints on Agriculture*, where he speaks of growing potatoes in *squares* or *beds*; and then say, whether plagiarism quite so scandalous was ever seen before. This gentleman's attachment to his own literary progeny is well known. When the late Minister, Perceval, had made a Bill of his altogether another thing; had taken the whole of the enactments away; had altered even the preamble; had made it as perfect a changeling as ever gipsy left in a farmer's wife's cradle; had stripped it of all but its *mere name*, Mr. CURWEN owned it, fathered it, and hugged it with paternal fondness. He ought, therefore, to have some consideration for the claims of others to their own.

This republication of TULL will strip many an agricultural philosopher of his borrowed plumes. The work, from being in an awkward form, and from containing mechanical matter which has been rendered useless by the many and great improvements in agricultural machinery, has been, comparatively, seldom seen. It has been, in a great measure, unknown *to the public* ; and has, therefore, been a very convenient mine for plagiarists to resort to. This will now be at an end. The work will be accessible to every body ; the public will no longer be imposed on, and the memory of the author will, at last, receive something like justice.

WM. COBBETT.

Kensington, 20th April, 1822.

PREFACE.

I THINK it unnecessary (if not impertinent) to trouble the reader with a long account of a short treatise, which he has before him. I might, as a rustic, omit the ceremony of a Preface, were it not reasonable to expect that an apology will be required for writing and publishing a book without the usual qualifications of an author. It was not, indeed, my own inclinations that prompted me to write; for (though almost all my life has been a continued sickness) I was so far from being inclined to the scribbling disease, that I had disused writing for above twenty years, before I was prevailed on to commit my thoughts upon Husbandry to paper. The solicitations by letter which I can produce (enough to make an ordinary volume) from persons of rank, who had seen my manner of planting St. Foin, &c., I could not absolutely refuse, notwithstanding the many just excuses I made for declining a task of which I knew myself incapable. A long confinement within the limits of a lonely farm in a country where I am a stranger, having debarred me from all conversation, except of low life, I foresaw that words would be wanting to express my thoughts properly, which is a misfortune that cannot be concealed. However, at first I did not think I should have had occasion of many, intending to write no more theory, than my notion of the pasture of plants, and to show how their roots are naturally adapted to receive the benefit of the Hoeing Husbandry, believing that the whole of that might have been comprised in a sheet or two, and the rest in about as many more; but books of Agriculture by chance coming to my hands (I never having read any of them before) occasioned more writing than I proposed.

It is no wonder that the style is low as the author, or the dust that is here treated of, since the whole was written in pains of the stone, and other diseases as incurable, and almost as cruel. But fine language will not fill a farmer's barn; neither does truth need any embellishments of art.

Connexion cannot be expected in a book composed of Notes written at different times, some in one year, some in others, as something new flowed from a different practice from what was common. Besides, as I was by sickness incapable of assisting when it was transcribed for the press, when many notes were to be inserted, my scribe not understanding their marks, misplaced many of them, some in the text, some in the margin, some in the wrong Chapters, many he left out, and more being mislaid which he did not find; among which last were the several weighings of my drilled crops and the neighbouring sown crops. As for these and much of the speculative part left out, if it had been more, it had been no great matter; but as some of the Chapter of Wheat is omitted, I shall rather insert what of it is necessary into the Preface, than that the beginner shall want it.

Several things caused the want of method. My scribe was so little skilled in country affairs as sometimes to set the cart before the horse, as he does, where he places the hoeing of turnips before the planting of them: but I presume this mistake will not be followed by any practiser, and then nobody will be injured by it, or by any such like Hysteron-Proteron to be found in the Chapter of Wheat, or elsewhere in the book.

Some things may be properly repeated, where used in different places for different purposes; but I doubt this will not excuse every repetition the reader will find.

I had no opportunity of correcting the sheets from the press, nor any friend to do it for me, which might have been some excuse for the faults of the Printer, had he not usurped a prerogative of coining of words. All he can pretend to say for his, and what I am sure I can truly say for my own

faults (which perhaps may be more) is that none of them are wilful.

As to the manner of filling the pages with notes, whether it be a fault or not may be doubtful; those who read merely for curiosity may blame it for being out of the mode; but the reader who intends to practise may like it the better; because by this means things are brought into the shortest compass, and he has in his view in one page as much matter as might be extended to several sheets by the introductory words which would be necessary to carry it on in a continued discourse. If any one shall be so censorious as to say, I use this contracting method, rather to save my own time in writing, than his in reading, perhaps his suspicion may not be very unjust; for he who practises Agriculture with effect, can have little time to spare for either. Besides, since I cannot pretend to say of this Treatise (as a late author says of his of much greater bulk on the same subject) that it is *Multum in Parvo*; I may hope in respect of its shortness, that it is not *Parvum in Multo*; and that brevity may make a dull discourse tolerable.

I beg pardon of the learned writers from whom I am forced to differ in opinion, as well as in learning; I assure them it is unwillingly and with regret that I do. No canon having limited what we shall think in agriculture, nor condemned any of its tenets for heresy, every man is therein a Free-thinker, and must think according to the dictates of his own reason, whether he will or no. And such freedom is given now-a-days in speculations in natural philosophy, that it is common to see people even in print maintain that there are Antipodes, that the earth moves round the sun, and that he doth not set in the sea, without being censured for these and many other formerly heterodox opinions; and any one may now upon solid arguments contradict Aristotle himself publicly any where, except in the schools. But that mine are such, which I bring for maintaining the principles I have advanced, I dare not affirm, being myself no competent

judge of them, as the reader (especially the practising reader) is. To his decision must be left all that is disputable; his partiality I have no reason to apprehend; because it is in some degree the interest of every one who lives by bread, that true principles be established in Agriculture; but none ought to be allowed as such, until they have been thoroughly examined. Truth is like gold, which the more it is tried the brighter it appears, being freed from dross. To be thus examined is the chief design of publishing this Essay on Tillage and Vegetation. And since great men seem to have made some mistakes of consequence in these matters, it may well be supposed that I may have made many more; but of such of these as shall be adjudged to be of substance, no man shall be more willing than myself, to sign their coudemnation; and I believe the judicious reader will excuse such mistakes as are merely of form. His candour will be also necessary for explaining some things wherein a mistake may arise from their being improperly expressed, and such he will construe as near as he can according to their intended meaning, and when by that misfortune they seem to jar in one part, he will endeavour to reconcile them by some other part, or by the tenor of the whole.

Every man is best satisfied with experiments made by himself; therefore I advise him who intends to practise, that he would repeat the trials of all mine before he relies upon them; not that I have been unfaithful in the making or relating any of them (for I only made them in search of the truth for my own satisfaction); nor doubt I but that, if he follow the same process, his will succeed as mine did, and he may very likely draw many more inferences from them than I have.

The experiment of artificially pulverised earth seeming to confirm what I had writ of the pasture of plants, I could not forbear inserting it into my Chapter of Tillage as soon as I had read it; but Mr. Evelyn takes no notice, that the surfaces of those fine parts, into which the earth is divided by such pulveration, is the vegetable pasture; but runs into a

simile which would better fit the climate of the Indian plants, than ours; therefore I omit his theory, lest it should offend the modesty of the ladies produced in a chaster climate, if my book should chance to have the honour of their perusal.

I have sometimes, for brevity's sake, produced only one instance instead of many which I could have given; I know that a single instance is not sufficient of itself, where there is no other proof; but when a thing is first fully proved in theory, I think one instance of fact in practice may be sufficient for its confirmation; and besides, the practiser will be abundantly furnished with instances from his own experience.

The matters of fact I have related, are not like some stories told by travellers, hard to be disproved if they are wrong.

I am in some doubt concerning the height of the great mustard plant; because I did not measure it, but by the idea I had of it four or five years after I saw it. It came accidentally on the side of a row of horse-hoed pease; it was in moist land that had been well-tilled and dunged. This being the first of the species that I had seen in this country, and having formerly taken half a pint of seed from one single plant of it in Oxfordshire, which was less than one lateral branch of this, I designed to measure the seed it would produce; but unluckily the people who cut the pease, chopped it to pieces with their hooks, because it spread very wide and stood in their way; the seed not being ripe I was disappointed in that; I might indeed have laid its parts together and taken its height, if I had then had any thoughts of writing, as I had not.

This last summer I saw the produce of two St. Foin plants carefully weighed; they grew both in the same ground, not far asunder, and of the same age (*viz.* seven years); the one stood single, and its product weighed thirty-seven ounces and a half; the other grew in a bunch among many neighbours, and was dug up, and its product, cut close to the root, weighed three grains, which is about a five thousandth part of the other. I think this proves that it is not extravagant to say,

that one single (or thin) St. Foin Plant may produce as much grass or hay as a thousand thick ones. And I have seen much greater single St. Foin plants than this.

As to the distances of rows, and other matters of practice, I could only tell the beginner what I have done, and the reasons (as far as a weak memory and my notes served me) whereon I proceeded: if he approves of them, they become his own, and he will proceed upon them as such; or if he doubt, it cannot cost much to satisfy himself by proper trials.

I have had great crops of turnips in rows three feet asunder, and much greater than I could ever obtain from rows thirty inches asunder; but one reason why I like six feet rows better is, that the largest turnips are best for oxen, and are pulled up and loaded with the least expense; for if they should be as small as the sown turnips hereabouts commonly are, that expense would go a great way into their value. I find that the least competent number will (*cæteris paribus*) always be the largest; but here is a great inconvenience happens to these, (especially when the sown turnips generally fail, as they do this year,) viz., as soon as they begin to head, the lawless people begin upon them, and the roots being then covered in the ground, they cannot easily know which of them they like until they have pulled them up, and so perhaps spoil ten for one that they take; but when the turnips have grown as big as apples, they make less waste, and carry away as many in a bag, as (if they were suffered to attain their full bigness) would load a wagon. Thus is the best crop soonest destroyed. I confess this is an objection, to which I can give no effectual answer, except this, that in a plentiful year, when the sown turnips stand, their slow growth renders them much sweeter for boiling than the drilled; which quality draws most of these customers to them, and when they are too thick, if they take them with discretion, they may rather mend than spoil the sown crop; not that they will spare the drilled turnips for this last reason (for they care not what injury they do), but because they like not the taste of them so well as that of the sown.

But, notwithstanding, the actions of these people are lawful in destroying my crops, because prohibited effectually by no law; yet I cannot help thinking it very hard, after paying four shillings in the pound to the poor's tax, and extravagantly for the little hand-work bestowed on my turnips, that the best product of my enclosures should not be my own. But, to speak properly, there can be no enclosures where every foot of ground that lies without doors is now common to these people.

The particular scheme of raising constant annual crops of wheat without dung or fallow, is as yet only upon probation; but by the six crops I have had in that manner, I see nothing against their being continued. This, it is true, requires greater care in the management than any other branch of the husbandry; but he who can do this without dung or fallow, may easily do it with one or both of them. And there may be such wet clayey land, which the plough cannot well pulverise without help of the ferment of dung; and in any sort of land, when it is suspected that the earth of the partitions was not well ordered in the summer, the best remedy is to strew a small quantity of malt-dust, or other fine manure upon the rows about the month of February; this will strengthen the plants and enable them to send their roots into the intervals the earlier in the spring.

Against the necessity of such wide intervals as I like best, my neighbour tells me, he has had five successive crops of wheat, and allows only four feet breadth to each row and its interval. His rows have been sometimes double and sometimes treble: but his ground is better than mine, and he bestows more hand-work upon it.

Many, it is like, will think this repetition of wheat-crops rather a curiosity than profitable, and in some circumstances it may be so.

For planting a single crop there are several methods. The narrowest interval wherein the hoe-plough can be profitably exercised among corn, is of thirty inches, and if this should be uneven by being the parting space, it could not be

horse-hoed ; therefore to keep it even, the drill must have two shares thirty inches asunder, the horse-path being in the middle betwixt them ; by this means the partition, the evenness of which is not so necessary, will be the parting space ; but take care that the point of one share do not incline downwards more than the other ; for if it should, it will run very deep into the ground, and the other will go very shallow. Also be sure not to let the hoe-plough go forwards and backwards, immediately in the same interval ; for if it do, the furrows will all lie on the same side, and then, at the next hoeing, the plough must go twice the length of each interval to plough one single furrow ; but this inconvenience is easily prevented when foreseen.

I have had many of these single crops of wheat in double rows, and always observed it to be made very strong by the use of the hoe only ; but I choose to have the intervals five or six inches wider.

There may be another way to have one crop of wheat, not yet mentioned, and this is to go with the treble drill twice instead of once upon each of the broad ridges, which will make sextuple rows with five partitions of seven inches each. I had an example of this the last year on one outside ridge. The first and sixth of these rows standing next to the hoed earth were strong, and so were the third and fourth that stood on the top of the ridge ; but the second and fifth standing lower, fell vastly short of the rest ; yet if these last had had more fine mould under them, I do not doubt but they might have been equal, or nearly equal, to the other.

The worst error I apprehend the beginner will be liable to is, to expect the benefit of pulverisation where his land is not pulverised. I had this year, in the middle of a field of wheat, about two or three acres, the earth in the partitions of which missed one of the hoeings in the precedent summer ; the colour of this wheat was plainly distinguished from that of the wheat on both sides of it at half a mile's distance in the spring, and was not above half the crop at harvest ; but if the rest of the piece had not had a hoeing more than this had,

the whole then being alike poor, it would not have so plainly appeared that the poverty was for want of one more hoeing.

By what I can hitherto observe in this husbandry, the best management always succeeds best, contrary to the proverb that says, that once in seven years, the worst husbands have the best corn; which shows that sometimes, even to this day, Ceres prefers her Virgilians for their demerits.

Although wheat, as an exportable commodity, be the fittest for a general improvement, yet, in some particular places, other vegetables, such as rape, or woad, may be more profitable than any sort of corn; and I have been told by one who has been long a dealer in rape, that he has made it larger and stronger in poor land by horse-hoeing, than he could ever make it in the richest land by the common method.

What pretenders or impostors have taught or said of this husbandry is unknown to me; nor am I answerable for any follies they may have committed, since I gave sufficient cautions against them in my Preface to the Specimen published for that purpose almost two years ago. To magnify it above what is just may be as injurious, as ignorantly to undervalue it. If any have gone rashly into the practice of it, it is probable they may go as rashly out of it, before they rightly know what it is.

Some seem to have no other notion of it, but as of a trick to get money, and write to me to send them servants to instruct them in it, not considering how that master is likely to be taught, who must learn of his servant, or that the being his scholar might in one sense justify the practice, (which is now become customary,) of the ploughman's correcting his titular master.

It is the most formidable objection against our agriculture, that the defection of servants and labourers is such, that few gentlemen can keep their lands in their own hands, but rather than make nothing of them, they let them for a little to tenants, who can bear to be insulted, assaulted, kicked, cuffed, and bridewelled with more patience than gentlemen are endowed with.

It is a public calamity, that the lands of a country must be all or mostly in the hands of rack-renters, whose interest it is (or at least they think so) that they never may be improved. We need not wonder at this when we see copyholders and leaseholders for lives oppose the improvement of inclosures for fear their fines should be raised.

The very different regard which every man naturally has to the interest of his heirs, from that of his successors, may be seen by the poverty and unimproved condition of St. Peter's patrimony compared with the hereditary states of Italy. And can we suppose that an English renter should have more honour in that respect than his Roman Holiness, who doth not fear being turned out by a successor in his lifetime, as the renter is sure to be when his lease is ended, if he has improved his farm and will not raise his rent?

The disreputation that gentlemen's understandings lie under, of wanting capacity to manage their lands with profit, as well as the most ignorant of the people can, would appear very unjust, could gentlemen contrive automata to do the business appertaining to tillage without hands, at the price that is reasonable to be given to servants and labourers for the same : not that there is any want of hands to receive our money, to take away our goods, and to beat us ; but such are wanting as will work faithfully at reasonable wages. By the general complaint of their behaviour, they more resemble French dragoons in time of persecution, than servants. It is not long since the public news gave an account of a noble lord's being insulted by footmen in the royal palace ; if thus be their manners when polished at court, what idea can be framed of their insolence whilst they follow the plough in the country ?

They who impute this misfortune of the land to the loss of the common law, which favoured agriculture, and was to our ancestors a better inheritance than that which came to them from their parents ; pretend to prove, that the Statute of Labourers hath turned more gentlemen out of their estates than the Norman Conquest did ; but their arguments being too numerous to be here recited, I shall only give them this general

answer, viz. That the lands of France are occupied with pleasure and profit by the owners, who live well upon them, and leave them planted and improved to their heirs, after having paid almost as much in taxes to their king, as our tenants pay in rent to their landlords for better land. And yet there is none of our common law in France; every thing there is decided by trials at discretion; but then, indeed, as the magistrates are arbitrary over the people, so the king is arbitrary over the magistrates, and in favour of tillage he will not suffer that the possessors of land shall be trampled on by servants and labourers, or other intimates of the country. Servants must there obey their masters, as far as is necessary for carrying on their business; and the labourer must be worthy of his hire; for if when he is able he will not work, neither shall he eat: and they are so unaccustomed to idleness, that none are starved that I can hear of.

This may perhaps serve for an answer to those who assert, that there can be no justice without juries; but whatever becomes of our lands, I pray God to defend us against a French government in England.

I can hardly believe, that the enormous behaviour of servants, &c., is so general as it is commonly reported to be. Sure the freeholders of counties would petition their respective representatives in parliament, in hopes that so public and heavy a grievance might be redressed; for the same power which took away part of the common law can restore it in its pristine purity, and enable the owners of lands to occupy and improve them as freely, at least, as their ancestors might before 5 Eliz.

The hoeing practice would profitably employ many more hands than the common husbandry, and procure more bread for them. But if through the aforesaid unfortunate circumstances it cannot be frequent in South Britain, which seems to be the most proper climate in the world for it; yet if it shall be useful to any other of his Majesty's dominions, I shall think my labour amply rewarded by that success. And even here those very inconveniences that attend arable land make

the improvement by St. Foin the greater ; and in this many others as well as myself have found my drill to be very advantageous ; not that the drill is necessary for planting it in all lands ; for in most soils that are rich and proper, St. Foin will prosper and last, in what manner soever it is planted ; but in a chalk with a poor thin staple, I never knew it succeed, unless when it was properly drilled, or else yearly manured by peat-ash, soot, or coal-ash, at a great expense.

The drill may also be serviceable to the old husbandry, in some respects, as when land having been ploughed dry, and lain till the rain comes, its surface is grown so hard, that the seed-wheat cannot be covered by harrows or drags, then the drill will make channels, sow in the seed, and cover it effectually.

Another general and no inconsiderable advantage of its use is, that it can save more than half the seed that is sown, and plant the land better ; they may also hand-hoe between the nearest rows if they please, or pull out the weeds without treading on the corn ; but it saves more of some sorts of seed than of others.

The first occasion of making my drill for small seeds was this : It was very difficult to find a man who could sow clover tolerably ; they had a habit (from which they could not be driven) to throw it once with the hand to two large strides, and go twice on each cast ; thus with nine or ten pounds of seed to an acre, two-thirds of the ground was unplanted, and on the rest it was so thick that it did not prosper. To remedy this, I made a hopper, to be drawn by a boy, that planted an acre sufficiently with six pounds of seed ; but when I added to this hopper an exceeding light plough, that made six channels eight inches asunder, into which two pound to an acre being drilled, the ground was as well planted. This drill was easily drawn by a man, and sometimes by a boy.*

* It is evident that the author was the original inventor of drills in England ; but his descriptions of those he alludes to are purposely left out in the present edition, being superseded by the improvements of later years.
—EDIT.

Fig. 1.

A 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 B

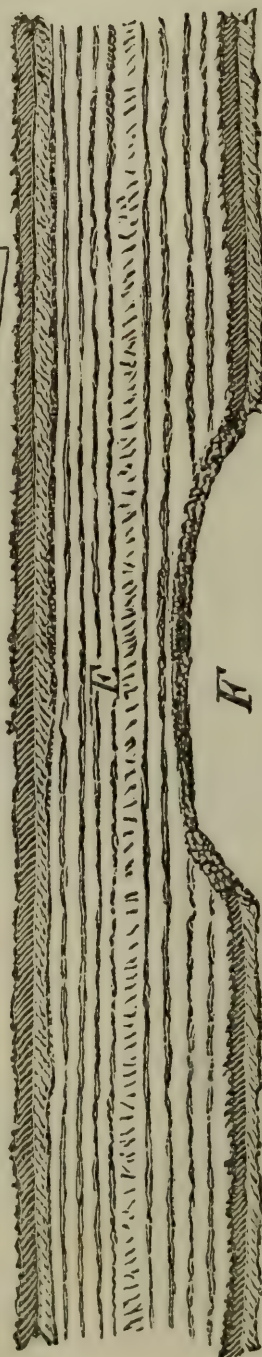
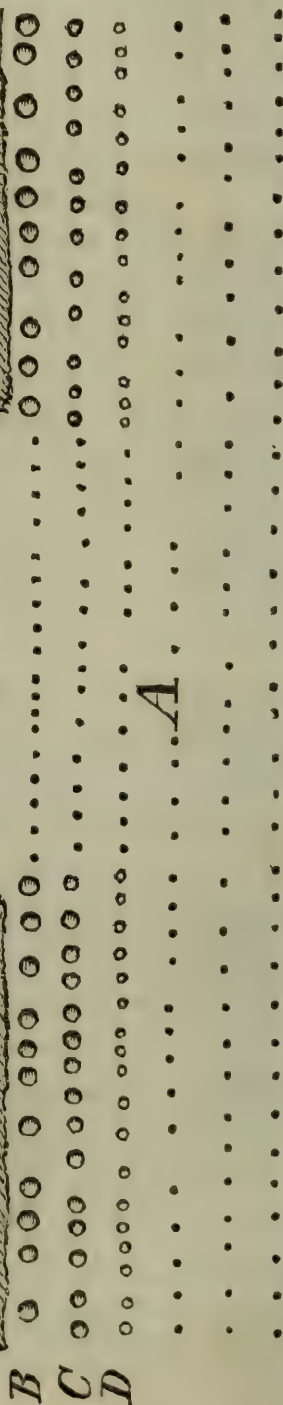


Fig. 2.



CHAPTER I.

OF ROOTS.

SINCE the most immediate use of Agriculture, in feeding Plants, relates to their Roots, they ought to be treated of in the first place.

Roots are very different in different plants, but it is not necessary here to take notice of all the nice distinctions of them; therefore I shall only divide them in general into two sorts, viz. *Horizontal-Roots*, and *Tap-Roots*, which may include them all.

All have branchings and fibres going all manner of ways, ready to fill the earth that is open.

But such roots as I call horizontal (except of trees) have seldom any of their branchings deeper than the surface or staple of the earth, that is commonly moved by the plough or spade.

The tap-root commonly runs down single and perpendicular, reaching sometimes many fathoms below.

In this manner descends the first root of every seed, but of corn very little, if at all, deeper than the earth is tilled.

These first seed-roots of corn die as soon as the other roots come out near the surface, above the grain, and therefore this first is not called a tap-root; but yet some of the next roots that come out near the surface of the ground, always reach down to the bottom of the pulverised staple; as may be seen, if you carefully examine it in the spring time; but this first root in saint-foin becomes a tap-root.

This, though it goes never so deep, has horizontal ones passing out all round the sides, and extend to several yards

distance from it, after they are, by their minuteness and earthy tincture, become invisible to the naked eye.

A Method how to find the Distance to which Roots extend horizontally.

A piece or plot dug and made fine in whole hard ground, the end *A* 2 feet, the end *B* 12 feet, the length of the piece 20 yards; the figures in the middle of it are 20 turnips, sown early and well hoed.

The manner of this hoeing must be at first near the plants with a spade, and each time afterwards a foot further distance, till all the earth be once well dug; and if weeds appear where it has been so dug, hoe them out shallow with the hand-hoe. But dig all the piece next the out lines deep every time, that it may be the finer for the roots to enter, when they are permitted to come thither.

If these turnips are all gradually bigger, as they stand nearer to the end *B*, it is a proof they all extend to the outside of the piece, and the turnip 20, will appear to draw nourishment from six feet distance from its centre.

But if the turnips 16, 17, 18, 19, 20, acquire no greater bulk than the turnip 15, it will be clear that their roots extend no further than those of the turnip 15 do, which is but about four feet.

By this method the distance of the extent of roots of any plant may be discovered.

There is also another way to find the length of roots, by making a long narrow trench, at the distance you expect they will extend to, and fill it with salt; if the plant be killed by the salt, it is certain that some of the roots enter into it.

What put me upon this method was an observation of two lands, or ridges, drilled with turnips in rows, a foot asun-

der, and very even in them; the ground, at both ends and one side, was hard and unploughed, the turnips not being hoed, were very poor, small, and yellow, except the three outside rows, *B*, *C*, *D*, which stood next to the land (or ridge) *E*, which land being ploughed and harrowed at the time the land *A* ought to have been hoed, gave a dark flourishing colour to these three rows; and the turnips in the row *D*, which stood furthest off from the new ploughed land *E*, received so much benefit from it as to grow twice as big as any of the more distant rows. The row *C*, being a foot nearer to the new ploughed land, became twice as large as those in *D*; but the row *B*, which was next to the land *E*, grew much larger yet.

A like observation to this on the land *E*, has been made in several turnip-fields of divers farmers, where lands adjoining to the turnips have been well tilled, all the turnips of the contiguous lands that were within three or four feet, or more, of the newly pulverised earth, received as great, or greater increase, in the same manner as my rows *B*, *C*, *D*, did; and what is yet a greater proof of the length of roots and of the benefit of deep hoeing, all these turnips have been well hand-hoed; which is a good reason why the benefit of the deep pulverisation should be perceivable at a greater distance from it than mine, because my turnips not being hoed at all, had not strength to send out their roots through so many feet of unpulverised earth, as these can through their earth pulverised by the hoe, though but shallowly.

This observation, as it is related to me, (I being unable to go far enough to see it myself,) sufficiently demonstrates the mighty difference there is between hand-hoeing and horse-hoeing.

F is a piece of hard whole ground, of about two perches in length, and about two or three feet broad, lying betwixt

those two lands, which had not been ploughed that year; it was remarkable, that during the length of this interjacent hard ground, the rows *B*, *C*, *D*, were as small and yellow as any in the land.

The turnips in the row *D*, about three feet distant from the land *E*, receiving a double increase, proves that they had as much nourishment from the land *E*, as from the land *A*, wherein they stood; which nourishment was brought by less than half the number of roots of each of these turnips.

In their own land they must have extended a yard all round, else they could not have reached the land *E*, wherein it is probable these few roots went more than another yard, to give each turnip as much increase as all the roots had done in their own land.

Except that it will hereafter appear, that the new nourishment taken at the extremities of the roots in the land *E*, might enable the plants to send out more new roots in their own land, and receive something more from thence.

The row *C*, being twice as big as the row *D*, must be supposed to extend twice as far; and the row *B*, four times as far, in proportion as it was of a bulk quadruple to the row *D*.

A turnip has a tap-root, from whence all these horizontal roots are derived.

And it is observable, that betwixt these two lands, there was a trench, or furrow, of about the depth of nine or ten inches, where these roots must descend first, and then ascend into the land *E*, but it must be noted, that some small quantity of earth was, by the harrowing, fallen into this furrow, else the roots could not have passed through it.

Roots will follow the open mould*, by descending perpen-

* A chalk-pit contiguous to a barn, the area of which being about forty perch of ground, was made clean and swept; so that there was not

dicularly, and mounting again in the same manner; as I have observed the roots of a hedge to do that have passed a steep ditch two feet deep, and reached the mould on the other side, and there fill it; and digging five feet distant from the ditch, found the roots large, though this mould was very shallow, and no roots below the good mould.

So in an orchard, where the trees are planted too deep below the staple or good mould, the roots, at a little distance from the stem, are all as near the upper superficies of the ground as of those trees which are planted higher than the level of the earth's surface.

the appearance of any part of a vegetable, more than in the barn's floor straw was thrown from thence into the pit for cattle to lie on; the dung made thereby was hauled away about three years after the pit had been cleansed, when, at the bottom of it, and upon the top of the chalk, the pit was covered all over with roots, which came from a witch-elm, not more than five or six yards in length from top to bottom, and which was about five yards above, and eleven yards from the area of the pit; so that in three years the roots of this tree extended themselves eight times the length of the tree, beyond the extremities of the old roots, at eleven yards distance from the body. The annual increased length of the roots was near three times as much as the height of the tree.

I am told an objection has been made from hence against the growth of a plant being in proportion to the length of its roots; but when the case is fully stated, the objection may vanish. This witch-elm is a very old decayed stump, which is here called a stagger, appearing by its crookedness, to have been formerly a plasher in an old white-thorn hedge wherein it stands. It had been lopped many years before that accidental increase of roots happened; it was stunted, and sent out poor shoots; but in the third year of these roots, its boughs being most of them horizontally inclined, were observed to grow vigorously, and the leaves were broad and of a flourishing colour; at the end of the third year all these roots were taken away, and the area being a chalk rock lying uncovered round the place where the single root, that produced all these, came out of the bank, no more roots could run out on the bare chalk, and the growth of the boughs has been but little since.

Wheat drilled in double rows in November, in a field well tilled before planting, looked yellow when about eighteen inches high; at two feet distance from the plants, the earth was hoe-ploughed, which gave such nourishment to them, that they recovered their health, and changed their sickly yellow to a lively green colour.

But the damage of planting a tree too low in moist ground is, that in passing through this low part standing in the sap is chilled, and its circulation thereby retarded.

One cause of people's not suspecting roots to extend to the twentieth part of the distance, which in reality they do, was from observing these horizontal roots, near the plant, to be pretty taper ; and if they did diminish on in proportion to what they do there, they must soon come to an end. But the truth is, that after a few inches, they are not discernibly taper, but pass on to their ends very nearly of the same bigness ; this may be seen in roots growing in water, and some other, though with much care and difficulty.

In pulling up the aforementioned turnips, their roots seemed to end at a few inches distance from the plants, they being, further off, too fine to be perceived by ordinary observation.

I found an extreme small fibre on the side of a carrot, much less than a hair, but through a microscope it appeared a large root, not taper, but broken off short at the end, which, it is probable, might (before broken off) have extended nearly as far as the turnip-roots did. It had many fibres growing out of it ; and I have seen that a carrot will draw nourishment from a great distance, though the roots are almost invisible where they come out of the carrot itself.

By the piece *F* may be seen that those roots cannot penetrate, unless the land be opened by tillage, &c.

And it is very likely and may be proved by another method, that as roots are but as guts inverted, they do bear, perhaps, that proportion to the stem or stalks of plants, as guts do to the bodies of animals*, viz. several times longer than the stalks.

As animals of different species have their guts bearing dif-

* An animal has but one gut, though its parts be distinguished by several names ; and the greater number of roots a plant has, the less length of them will suffice.

ferent proportions to the length of their bodies ; so it is probable different species of plants may have their roots as different. But if those which have shorter roots have more in number, and having set down the means how to know the length of them in the earth, I leave the different lengths of different species to be examined by those who will take the pains of more trials. This is enough for me, that there is no plant commonly propagated, but what will send out its roots far enough, to have the benefit of all the hoed spaces or intervals I in the following chapters allot them, even though they should not have roots so long as their stalks or stems.

(Roots of amphibious plants grow longer when in earth than when in water.)

And this great length of roots will appear very reasonable, if we compare the largeness of the leaves (which are the parts ordained for excretion) with the smallness of the capillary roots, which must make up in length or number what they want in bigness, being destined to range far in the earth to find out a supply of matter to maintain the whole plant ; whereas the chief office of the stalks and leaves is only to receive the same, and to discharge into the atmosphere such part thereof as is found unfit for nutrition ; a much easier task than the other, and consequently fewer passages suffice, these ending in an obtuse form ; for otherwise the air would not be able to sustain the stalks and leaves in their upright posture ; but the roots, though very weak and slender, are easily supported by the earth, notwithstanding their length, smallness, and flexibility.

Plants have no stomach, nor *oesophagus*, which are necessary to convey the mass of food to an animal ; which mass being exhausted by the lacteals, is eliminated by way of excrements ; but the earth itself being that mass to the guts (or roots) of plants, they have only fine recrement, which are thrown off by the leaves.

In this animal and vegetable bodies agree, that guts and roots are both injured by the open air ; and nature has taken an equal care that both may be supplied with nourishment, without being exposed to it. Guts are supplied from their insides, and roots from their outsides.

All the nutriment, or pabulum, which guts receive for the use of an animal, is brought to them ; but roots must search out and fetch themselves all the pabulum of a plant ; therefore a greater quantity of roots, in length or number, is necessary to a plant, than of guts to an animal.

All roots are as the intestines of animals, and have their mouths or lacteal vessels, opening on their outer spongy superficies, as the guts of animals have theirs opening in their inner spongy superficies.

The animal lacteals take in their food by the pressure that is made from the peristaltic motion, and that motion caused by the action of respiration, both which motions press the mouths of the lacteals against the mass or soil which is within the guts, and bring them into closer contact with it.

Both these motions are supplied in roots by the pressure occasioned by the increase of their diameters in the earth, which presses their lacteal mouths against the soil without. But in such roots as live in water, a pressure is constantly made against the roots by the weight and fluidity of the water : this presses such fine particles of earth it contains, and which come into contact with their mouths, the closer to them.

And when roots are in a tilled soil, a greater pressure is made against them by the earth, which constantly subsides and presses their food closer and closer, even into their mouths, until itself becomes so hard and close, that the weak sorts of roots can penetrate no further into it, unless re-opened by new tillage, which is called hoeing.

The colour of roots being different from that of leaves, and some other external parts of a plant, is no more an argument

against the circulation of the sap, than the colour of the guts, being different from that of the lungs, and other parts of an animal body, is an argument against the circulation of the blood.

As far as I can yet discover, all roots, properly so called, are white ; and the red carrot, when it stands for seed, sends out in the spring, from all parts of it, fibrous roots as white as those of any other plant. The white colour proceeds from the chy-liferous vessels, or rather from the waterish, wheyish chyle contained in them.

When a good number of single-mint stalks had stood in water until they were well stocked with roots from their two lower joints, and some of them three joints, I set one into a mint-glass, marked *A*, full of salt water : this mint *A* became perfectly dead within three days.

Another mint, marked *B*, I put into a glass of fair water, but I immersed one string of its roots, being brought over the top of that glass, into another glass of salt water, contiguous to the top of the other glass ; this mint died also very soon.

Of another, marked *C*, (standing in a glass of water and earth till it grew vigorously,) I tied one single root into a bag which held a spoonful of dry salt, adjoining to the top of the glass, which killed this strong mint also. I found that this salt was soon dissolved, though on the outside of the glass, and though no water reached so high as to be within two inches of the joint which produced this root. The leaves of all these were salt as brine to the taste.

To another, marked *D*, I put an upper root into a small glass of ink instead of a bag of salt, in the manner above mentioned ; this plant was also killed by some of the ink ingredients. The blackness was not communicated to the stalk or leaves, which inclined rather to a yellowish colour as they died, which seemed owing to the copperas.

I made a very strong liquor with water, and bruised seeds of wild garlic, and filling a glass therewith, placed the top of

it close to the top of another glass, having in it a mint, marked *E*, two or three of the upper roots of which put into this stinking liquor, full of the bruised seeds, and there remaining, it killed the mint in some time, but it was much longer in dying than the others were with the salt and ink. It might be because these roots in the garlic were very small, and did not bear so great a proportion to their whole system of roots as the roots by which the other mints were poisoned did to theirs.

When the edges of the leaves began to change colour, I chewed many of them in my mouth, and found at first a strong aromatic flavour of mint, but that was soon over; and then the nauseous taste of garlic was very perceptible to my palate.

I observed that when mint *F* had stood in a glass of water until it seemed to have finished its growth, the roots being about a foot long and of an earthy colour, after putting in some fine earth which sunk down to the bottom, there came from the upper joint a new set of white roots, taking their course on the outside of the heap of old roots downwards, until they reached the earth at the bottom, and then, after some time, came to the same earthy colour with the old ones.

The mint *G* being well rooted from two joints, about four inches asunder, I placed the roots of the lower joint in a deep mint glass, having water at the bottom, and the roots of the upper joint in a square box, contrived for the purpose, standing over the glass and having a bottom that opened in the middle, with a hole that shut together close to the stalk, just below the upper joint; then laying all these upper roots to one corner of the box, I filled with sand dried in a fire shovel, and found that, in one night's time, the roots of the lower joint which reached the water at the bottom of the glass, had drawn it up, and imparted so much thereof to those roots in the box above, that the sand, at that quarter where they lay, was very wet, and the other three corners dry. This experiment I repeated very often, and it always succeeded as that did.

And for the same purpose I prepared a small trough, about two feet long, and placed a mint-glass under each end of the trough ; over each glass, I placed a mint, with half its roots in the glass the other half in the trough : the mints stood just upon the ends of the trough. Then I covered these roots with pulverised earth, and kept the glasses supplied with water ; and as often as the white fibrous roots shot through the earth, I threw on more earth, until the trough would hold no more, and still the white fibres came through, and appeared above it, but all seemed, as I saw by the help of a coarse microscope, to turn, and when they came above ground, their ends entered into it again. These two mints grew thrice as large as any other mints I had, which were many, that stood in water, and much larger than those which stood in water with earth in it ; they being all of an equal bigness when set in, and set at the same time. Though these two standing in my chamber never had any water in their earth, but what those roots, which reached the water in the glasses, sent up to the roots which grew in the trough. The vast quantity of water these roots sent up being sufficient to keep all the earth in the trough moist, though of a thousand times greater quantity than the roots which watered it, makes it probable that the water passed out of the roots into the earth, without mixing at all with the sap, or being altered to any degree. The earth kept always moist, and in hot weather there would not remain a drop of water in the glasses, when they had not been fresh supplied in two days and one night ; and yet these roots in the glasses were not dried, though they stood sometimes a whole day and night thus in the empty glasses. These two mints have thus lived all one summer, and are marked *HH*.

Remarks on the Mints, &c.—Though the vessels of marine plants be someways fortified against the acrimony of salt, as sea-fish are, yet the mints *A*, *B*, *C*, all show that salt is poison to other plants.

The reason why the salts in dung, brine, or urine, do not kill plants in the field or garden is, that their force is spent in acting upon and dividing the parts of earth: neither do these salts, or at least any considerable quantity of them, reach the roots.

I tried salt to many potatoes in the ground, being undermined, and a few of their roots put into a dish of salt water, they all died sooner or later, according to their bigness, and to the proportions the quantity of salt applied did bear to them.

By the mints *B*, *C*, *D*, *E*, it appears that roots make no distinctions in the liquor they imbibe, whether it be for their nourishment or destruction. And that they do not insume what is disagreeable, or poison to them, for lack of other sustenance, since they were very vigorous, and well fed in the glasses at the time when the most inconsiderable part of their number had the salt, garlic, and ink offered to them.

The mint *F* shows, that when new earth is applied to the old roots, a plant sends out new roots on purpose to feed on it; and that the more earth is given it, the more roots will be formed, by the new vigour the plant takes from the addition of earth. This corresponds with the action of hoeing; for every time the earth is moved about roots, they have a change of earth which is new to them.

The mint *G* proves, that there is such a communication betwixt all the roots, that when any of them have water, they do impart a share thereof to all the rest: and that the root of the lower joint of this mint had passages, or vessels, leading from them, through the stalk, to the roots of the upper joint; though the clear stalk (through which it must have passed), that was betwixt these two joints, was several inches in length.

This accounts for the great produce of long tap-rooted plants, such as Lucerne and St. Foin, in very dry weather;

for the earth, at a great depth, is always moist. It accounts also for the good crops we have in dry summers, upon land that has a clay bottom; for there the water is retained a long time, and the lower roots of plants which reach it do, like those of this mint, send up a share to all the higher roots.

If those roots of a plant, which lie at the surface of the ground, did not receive moisture from other roots which lie deeper, they could be of no use in dry weather. But it is certain, that if this dry surface be moved or dunged, the plant would be found to grow the faster, though no rain fall; which seems to prove, both that the deep roots communicate to the shallow a share of their water, and receive in return from them a share of food, in common with all the rest of the plant, as in mints *F*, *G*, *HH*, they did.

They receive it by their capillary sap vessels, after it has been purified and prepared by the leaves fit for nourishing all parts of the plant.

The two mints marked *HH*, show, that when the upper roots have moisture, (as they had in the earth in the trough, carried thither first by the lower roots,) they impart some of it to the lower, else they could not have continued plump and fresh, as they did for twenty-four hours in the empty glass. And I have since observed them to do so, in the cooler season of the year, for several weeks together, without any other water than what the upper roots conveyed to them from the moist earth above in the trough. I know not what time these roots might continue to be supplied thus in the hot weather, because I did not try any longer, for fear of killing them.

It is certain, that roots and other chyle vessels of a plant have a free communication throughout all their cavities, and the liquor in them will run towards that part where there is least resistance; and such is that which is the most empty, whether it be above or below; for there are no valves that

can hinder the descent or ascent of liquor in these vessels, as appears by the growing of a plant in an inverted posture.

But it must be noted, that the depth of the glass protected the roots therein from the injury of the motion of the free air, which would have dried them if they had been out of the glass.

In this trough is shown most of the hoeing effects, viz. that roots, by being broken off near the ends, increase their number, and send out several where one is broken off.

That the roots increase their fibres every time the earth is stirred about them.

That the stirring the earth makes the plants grow the faster.

The mint discharging such a vast quantity of water into the earth in the trough, shows that there are passages by which the roots do, as it were, spew out what is superfluous, and would surfeit the plant if it entered into the sap in too great abundance, more and faster than it could be purified by the leaves.

Whether this water, which is so soon returned out of the roots, be at all altered during its short stay there, I cannot say, until I see the consequence of some experiments, which will, I believe, inform me, viz.,

Half the fibrous root of garlic set in water, the other half in a trough of flour above it, as those of the mint were; if the water the under-garlic roots send to the upper be spewed out into the flour of a garlic taste, then we know it is altered, otherwise conclude it is not altered. A mint is not of flavour strong enough to prove this.

Though the earth and water by passing twice through the pores of garlic roots should possibly acquire some small alteration, it would be no proof of its being converted into sap; for if you steep this strong scented plant in a considerable quantity of water, it will all have a tincture of its stench

from its effluvia, and yet nobody will believe such water is become sap; yet I know not whether there are enough of those effluvia in its fibrous roots, not having prosecuted that experiment. And now, upon further consideration, I think mint a much fitter plant than garlic, to show the difference there is between chyle and sap, because its effluvia are not so strong, and the fibrous roots of the mint may be drawn out at every joint of the stem. The chyle may be had from fibrous roots near the top, which enters at the roots at its bottom.

Note. It is best to lop off the tender top of the mint, in order to make the stem the stronger, to afford the more high roots, when set in water; for no root will ever come out of it in the open air.

CHAPTER II.

OF LEAVES.

LEAVES are the parts, or bowels of a plant, which perform the same office to sap, as the lungs of an animal do to blood; that is, they purify or cleanse it of the recrements, or fuliginous steams, received in the circulation, being the unfit parts of the food; and perhaps some decayed particles, which fly off the vessels, through which blood and sap do pass respectively.

Besides which use, the nitro-aerious particles may there enter, to keep up the vital ferment or flame.

Mr. Papin shows, that air will pass in at the leaves, and out through the plant at the roots, but water will not pass in at the leaves; and that if the leaves have no air, a plant will die, but if the leaves (being left on the outside of the receiver, parted by a hole, cemented with wax) have air, though the root remain in water in vacuo, the plant will live and grow.

Dr. Grew, in his *Anatomy of Plants*, mentions vessels which he calls network, cobweb, skeins of silk, &c. But above all, the multitude of air-bladders in them, which I take to be of the same use in leaves as the vesiculæ are in lungs. Leaves being as lungs inverted, and of a broad and thin form, their vesiculæ are in contact with the free open air, and therefore have no need of trachea, or bronchia, nor of respiration.

Lungs being situate within the animal's body, their vesiculæ could have no communication with the atmosphere, without the trachea and bronchia; and even there, the

aerial influence would be intercepted by the fuliginous and recrementitious steams, were they not thence expelled by the systole in expiration ; the want of which is the cause of an asthma, a disease leaves are not affected with, because their vesiculæ are always contiguous to the nitrous air, which continually presses against them.

Sanctorius, who, by his static chair, found five-eighths of the nourishment, or a weight equal to it, taken by a man, passes off by insensible perspiration ; could he have invented any method to calculate the quantity of that part of those perspirations which pass off through the trachea from the lungs, I believe he would have found the most of it to pass that way*.

When the blood enters the lungs from the right ventricle of the heart, it is so full of this fuliginous matter, that its colour is blackened with it. This is all discharged in passing through the lungs ; for when the blood arrives at the heart's left ventricle, being purified of its recrements, it is become of a pure, florid, red colour ; and in cold weather these steams may be seen to issue out from the trachea in great quantities, which are constantly supplied by the nourishment taken in at the lacteals of the guts. Sanctorius's other three parts were but as the soil from whence the five parts are extracted.

Since leaves do so much resemble lungs in the anatomy of their organs, it is very reasonable to believe they imitate them in their office ; though the fineness of the vegetable vessels, and slow motion of the sap, will not admit a demonstration of the sap's circulation by ligatures, but we have other reasons which do sufficiently prove it.

* See Mr. Papin's Experiments of the Pneumatic Engine ; it appears that water will pass out at the leaves, but not from without into them ; and that nothing can be found to pass in or out by the bark, unless the bark be cut.

Sap is a word, which custom has made proper to signify the blood of plants.

Roots is the word used for the guts of a plant.

Leaves the words used for the lungs of a plant.

Pabulum the word used for the food of plants, before taken in by the roots; and also for the chyle, which is the most proper word for it, after taken in, before it is mixed with the sap in the leaves.

Pabulum is sometimes the word used for the nourishment that the chyle gives to the sap, and sometimes for the nourishment and increase that the sap gives to a whole plant.

I believe that the whole stress of the arguments against the circulation of sap, consists in the mistake of making no distinction between chyle and sap which is no less than between the chyle and blood of an animal: and this distinction, I think, may be fully demonstrated by repeating the experiment of my mint *G*, p. 15, wherein the liquor which entered the roots at the bottom of the glass, and issued out at the other roots in the box from near the middle of the stalk (which being lopped was not above nine inches), appeared, both in taste and colour, to be no way altered from the water at the bottom of the glass, from whence the lower roots imbibed it. The colour of the juice of the bruised mint, when pounded and strained, was greenish, and would have been greener, no doubt, if it could have been separated from all mixture of that other liquor which I call chyle.

The juice or sap of mint, though mixed with the chyle, has a strong aromatic flavour; but the chyle, which is in the root, and all that issues out of a root is insipid, which you may prove by sucking a mint-root, when taken out of water, except you chew or bruise it, for then it is possible there may be some very small quantity of sap expressed from the capillary vessels, that run in the coats of the root to nourish it. Yet I could never find any taste in mint-roots that way neither, the proportion of sap therein being too minute to affect my palate.

But if sap can be tasted in chewing the fibrous roots, as doubtless it may in some strong-scented plants, then let us consider what will follow upon what *Equivocus* affirms, viz. "That sap is not made in the root, and that the root contains a liquor different from the sap or liquor of the stem." From hence he argues against the circulation of the sap: "for, says he, if the sap should descend from the stem into the root, what a jarring would there be between these two different liquors or juices?" To which I answer, that the chyle and sap being contained in different vessels, the chyle in the larger cavities of the root, the sap in the fine capillaries, which supply nourishment to the vessels of the root, they never mix there, and therefore there can be no jarring betwixt them: and if, on chewing the fibrous roots (which I suppose is best done when they are dry), sap is tasted in them, it will be a proof, that sap not being made in the root, descends thither from that part of the plant where it is made: and that part must be it that has the most secretory ducts, which send off what is dissentaneous to sap; and I think the leaf is allowed to be this part; and it is proved to be so, when the root being in water without, and the rest of the plant being within the exhausted receiver, nothing is found to issue out from any other part, but from the leaves.

For further proof, I would propose to the curious, that a good quantity of this liquor, which may easily be obtained from an upper root, after it has passed through a great part of the stalk, be distilled, and an equal quantity of sap expressed from the pounded stalks of mints. I am confident the different quantities of spirit, so drawn from these distillations, will convince them of the difference there is between chyle and sap.

There may be yet another proof, if the like experiment to mine of mint *G* be made with some plant that has a red sap, as the red beet hath.

When the chyle has thus passed through the body of such

a red plant, and yet retains its white colour, there will be no more room for arguments against the circulation of the sap, taken from the motion of this chylous liquor.

The roots that supplied the earth in my trough with moisture sufficient to maintain my mint plants (marked *HH* in p. 16) therein a whole summer, gave me great reason to believe, that such a quantity of liquor, imbibed by these roots, was not converted to sap in them. And, indeed, if sap could be so soon made by the roots, great profit might be made of some plants, by obtaining more sap from such upper roots in a few hours, than the whole sap of the same plant amounts to.

When the roots of a plant are set in water without, and its leafy part included in the exhausted receiver, water will distil from the leaves, and forming drops thereon, fall down into the receiver; but when the leafy part is in water without, and the roots included within the exhausted receiver; no liquor will come out from the roots, as in the experiment in "*Philosophical Transactions*." Here, if water enter the leaves, it is a proof, that when the chyle vessels have delivered their liquor to the sap of the leaves, there are a sort of valves which prevent both sap and water from entering the chyle vessels from the leaves, for if either of them did, it must have issued out at the roots in the empty receiver, where there was no resistance to balance the external pressure; therefore, what water entered the leaves must have remained only in the sap; and in all probability circulated with it, as doth the water which enters the capillary veins by the pores of the skin of men that swim or bathe, and also of washerwomen.

There can be no other valves in the chyle-vessels, except the above-mentioned, because the chyle can move both ways, as it is proved by a willow growing in an inverted posture.

Since no sap is ever found in the cavity of a root, or of any of its appendages (as may be proved by my said mint *G*,

&c. and such appendages will come out all over a plant, as at the end of a brier) we may conclude, that sap is not made in the root, nor in passing out of the root into the stem, as *Equivocus* asserts, because the chyle continues to be chyle all over the body of the plant in its proper vessels, until it reaches the leaves, and in them it is certainly mixed with the sap, because both the mint-sap and garlic-juice were tasted in the leaves of my mint *E*, in p. 15.

If the garlic-juice that was taken in by mint *E*, had been made mint-sap, by being purified by the root, stem, or bark of the mint, it could not have remained garlic-juice in the mint-leaves, as by the taste it plainly did.

It is very probable, that the chyle mixes with the sap at the entrance into the leaf, and that the taste of mint and garlic in the same leaf, is from a mixture of them there, in the sap-vessels only, as the chyle and blood are mixed in the blood-vessels of animal lungs; for no chyle-vessels can ever be found in a leaf, as they may be in every other external parts of a tender-rind plant, and pure chyle drawn from them.

It is certain the chyle must enter the sap-vessels somewhere, else how could the sap be diluted or nourished? And since the leaf is the only part free from chyle-vessels, though chyle is there tasted, I see no reason to doubt of the chyle's being in the sap-vessels of the leaf, and not there in their own proper vessels.

The reason why the chyle (or water) passed out at the roots that were in earth in the trough, and in sand in the box, was, because those roots had not so equal a pressure to their whole superficies from the earth and sand as the other roots had from their water; for earth and sand have larger pores than water, some of those pores were filled only with air, whose weight was no counterpoise against the water, which, having lesser pores, pressed against more of the superficies of the roots contained in it, and thereby caused the chyle

to issue out at the superficies into those pores of the earth and sand where was less resistance.

And the same reason may be given, why some of the chyle, taken in by roots which are in water and earth may pass out at other roots of the same plant that have less water in the earth wherein they are included.

Now this chyle (by some mistaken for sap) entering at the roots, has, doubtless, a progressive motion only, and doth all, except in case of unequal pressure just mentioned, march to the leaves, thence never to return, save such parts of it as are proper and sufficient to dilute and nourish the sap; all the rest, I think, is universally agreed to perspire off from the leaves.

And this motion of the vegetable chyle agrees with that of the animal chyle, which, likewise, is only progressive, it ascending to the subclavian vein, not by pulsion, any more than the vegetable chyle.

Roots, indeed, differ from guts in this, that the cavities of roots continued quite through a plant, serve as chyle-vessels, which office the cavities of guts cannot supply in an animal, because these carry the mass from whence the chyle is imbibed by the lacteals, and which is carried from their insides or cavities outwards; and therefore it was necessary for guts to have other vessels to carry the chyle to the blood.

But roots taking in their chyle from without, needing no other vessels, serve by themselves for both uses, viz. to separate the vegetable chyle from the mass of earth wherein they are included, and to carry it in their own cavities up to the leaves, where it is mixed with the sap.

True sap never passing out nor in at the leaf, nor at any other part of a plant, unless wounded, must be made (of chyle) within the plant.

And must either circulate or stagnate; and stagnation of sap is as sure death to a plant, as stagnation of blood is

to an animal, for without motion it would corrupt and putrify; and this motion must be circular, because, it being proved that the chyle is joined with the sap in the leaves, and allowed that sap is made of, or rather nourished by, chyle (which, I believe, nobody who considers will deny), it follows, that the sap passes from the leaves to all parts of the plants, as blood doth from the lungs of an animal for the nourishment of the whole body; and if such part of it as is not spent in nourishing the plant were not returned back to the leaves, there could be no sap in them to mix with the chyle. This motion from the leaves, and returning to them, is what I call circulation, by what means soever it is performed.

There may be other ways by which this circulation of sap is performed, besides pulsion: I am inclined to think trusion the most likely; and, as I remember, Mr. Bradley has accounted for it this way, viz., as heat rarefies the sap in one part of a plant more than in another, it must require more room, and consequently expand itself, and move further, thrusting or pushing on that which is next it; but far be it from me to attempt explaining the manner of it.

If the analogy there is in other respects between a plant and an animal, holds between sap and blood, there must be in a plant vessels analogous to arteries and veins, and even to capillaries; for it is said by the learned, that blood does not nourish the vessels by passing through their cavities, but by that which is sent out of the capillary arteries into the parenchyma. How very unlikely is it then, that the plant should be immediately nourished by the crude chyle passing once from the root through the cavities of the chyle-vessels up to the leaves, and thence all into the atmosphere?

The argument brought against this circulation, from the great quantity of water imbibed and perspired in a short time by the sunflower, will be answered by the very short and direct passage which that liquor hath from the root to the leaves,

which perform the office of kidneys to the redundant aqueous part of this chyle.

The chyle in an animal has but a short passage from the lacteals to the blood ; but yet much longer than the passage of the vegetable chyle.

The animal chyle, though not moved by pulsion, arrives soon at the subclavian vein ; and there joining with the blood, goes with it immediately to the heart ; whence it is by pulsion driven through the lungs, being therein more intimately mixed, and also purified ; and that which is not thence thrown off by expiration, hath not a long journey, by the emulgents to the kidneys, which separate and send down a greater or lesser quantity of urine, and quicker or slower, in proportion to the quantity of liquor drunk ; and this is sometimes much more than is necessary. As I remember two Swiss soldiers at Montpellier were carried before the governor by their landlady, for refusing to pay for fifty-six pots of very strong wine, which they drank at one sitting : the dispute was about the odd pots, for they said, they never used to drink more than fifty in that time ; but the woman insisting on her proof, the governor paid for the odd. A Montpellier pot contains three English pints.

Now, I suppose this quantity is vastly greater than is necessary for a man to drink in that time ; yet not so much unnecessary as the quantity of water was to Mr. Hales's sunflower ; for I am in no doubt, but that it would have thrived well with the fiftieth part it imbibed ; because I have seen a sunflower grow very well in dry rich ground in a dry summer ; and then it might drink no greater quantity, than a man in his regular way of living, bulk for bulk.

The lungs cannot do the office of kidneys in an animal, because being at such a distance from the open air, so great a quantity of liquor necessary to be sent off, though rarefied to vapour, would cause suffocation in the bronchia and trachea ;

but leaves being in contact with the air, can execute the office of kidneys without that danger.

Nature has other ways of discharging the aqueous part of the blood, besides kidneys, even in some animals, as in fowl; for to them their feathers serve as kidneys, having no other, and yet they drink plentifully.

Fishes also have their lungs almost without their bodies, like plants, and seem to have no other passage for discharging their urine but their lungs, though fishes are accounted great drinkers.

No body doubts of the circulation of blood in all animals, though in many very small ones it cannot be proved by demonstration; and there is no more reason to doubt of it in plants than in oysters, mites, and in many species of insects too minute to be seen by the naked eye.

The argument taken from the liquor issuing plentifully out of the lower part of a notch, or a disbarked gap of a tree or branch set in water, and not from the upper part of it, is answered by showing, that the greatest part of that liquor passes out of the leaves without descending; and so cannot issue out at the upper part of the gap; and the sap being thicker, and in less quantity, has probably a much slower motion, and is not so apt to pass out at a cut, as the aqueous chyle is; for a plant never bleeds to death, but when the sap is very much diluted by a great mixture of chyle.

As to what is offered by *Equivocus* against the circulation, from the same stocks producing different sorts of pears, it may be answered, that the ovaria of plants are a part of their very substance, and do not fluctuate or circulate in their juices; so that each scion or bud, contains, actually adhering to itself, all the fruit and plants that ever will proceed from it; and though the same juices may so agree with the stock and the scions, as to nourish them all, the scions being different from the stock and from one another, yet the juices cannot change

the sort of fruit, that being an organical part, only nourished, extended, and increased by the juices.

Yet we see that when the nature of a stock is very different from the scion, the juices made by their different vessels are so disagreeable to each other, that one or both, but always the scion, will die.

It is true, that the juice of a stock, mixing with that of the scion, may a little alter the flavour of its fruit; as a pear grafted upon a quince may be mended, but if grafted upon a white thorn will be worsted: but this may very well be from that little alteration the sap receives in circulating through the vessels of the stock.

We find by inoculation, that a bud is an entire little tree, containing within itself its proper seed, and all the trees that ever can proceed from it; for to suspect that all the individuals of plants and animals did not actually exist within the first of each of their respective species, would be to suspect that there is an equivocal generation of them.

The last objection I shall speak to is this:

It is asked by *Equivocus*, How goes on the circulation, when a part is cut off from a plant? Why, I say, it goes on as the circulation of blood does in a man upon the amputation of a leg or an arm.

As for the part cut off from the plant, provided it be at a proper season stuck into the ground, if it have a spongy rind it will grow; the roots, being the chyle-vessels, passing all over the plant, are sent out from that part of the bough which is in the ground, and doing that for it which all fibrous roots do in the earth; the bough sends out leaves also, which are contained all over it, which are explained in the air, and then the bough becomes a tree.

Why the roots should choose to strike out in the earth rather than in the air, and the leaves in the air rather than in the earth, I cannot tell: it is by an unknown sort of

mechanism, or rather instinct, which I can no more pretend to explain, than I can the cause of gravitation.

But I can see no reason to believe, that a plant is a mere Thermometer, nor that the vegetable life can be carried on any more than the animal life, without a circulation of that juice, which is necessary to nourish and maintain it.

I might urge another argument, against those who assert that the sap is made by the bark in its ascent only; which argument is, that if it were so, the sap must be more pure the higher it ascended, and pass off into the atmosphere in its greatest perfection; which would intimate, that sap was not designed by nature for nourishment of plants, but to be thrown away as useless, when it was made the most useful for that purpose.

The young potato is nourished from the plant*, at the end of a white string, by vessels passing from the bottom of the plant; at the same time, when salt being bound to this string, passes by other vessels of the same string, contrary to the other, into the body of the plant, and may be tasted in the leaves.

It must be the chyle-vessels that imbibe the salt, as they would have imbibed the chyle, had the string been in contact with earth, as it was with the salt, all fibrous roots being parts of the system of chyle-vessels, as leaves seem to be of the sap-vessels; the former carrying their contents to the leaves, that were not able to separate or discharge the salt from the agreeable part of the chyle, nor to

* It must have its nourishment from the mother plant, because, the young potato and string being laid on tiles, could have no nourishment from the earth, and yet it will grow large, and have no taste of salt in it, that being stopped in the leaves, and kills the mother potato. If the salt did enter the inmost vessels, and carry the nourishment to the young one, that would taste of the salt, which is applied nearer to it than to the mother.

carry the salt back to the stem, in their sap-vessels ; which, it is probable, were soon corroded by the saline acrimony. The salt appeared to remain in the leaves, by their tasting almost as strong as pure crude salt.

Thus, it is no wonder that there should not be salt enough carried from the leaves to the young potato to be tasted in it ; and it could not be carried to it, immediately from the string, without first passing the leaves : because the sap-vessels never send out roots, and therefore could not imbibe the salt at the string : the chyle-vessels only send out roots, as the sap-vessels only send out leaves. Neither could any salt pass to the young potato in the chyle-vessels, they always carrying their liquor towards the leaves, but never from them ; except when they supply roots that happen to be empty, as in the case of mint *HH*, mentioned in page 16.

A quantity of matter, nearly equal to that received by the roots, is constantly carried off, as appears by Dr. Woodward's experiments ; and I believe nobody ever doubted but that it had its chief exit from the leaves.

It is not likely that all those curious vessels which appear in the texture of the leaf, should be designed for the recrements and sap to pass once through them, and thence to fly away together : they might as well pass off without the use of the leaves, at the place where they are inserted into the plant, if the leaves were off*.

* Mr. Hales in his Vegetable Statics, found that a plant in summer imbibed and perspired less water when its leaves were pulled off, than when they were on ; but this might be partly from the contraction of the vessels by the air, at the wound where the leaves were broken off. He also proves that this quantity of liquor, that passes through a leafless plant in summer (though it be less than what passes through a plant that has its leaves on) is vastly greater than what passes through the same plant in winter ; and yet the plant with the great quantity of liquor (or nourishment) in summer

And to think that the nourishment and sap of a plant pass off together, is no less absurd, than to think that the blood and chyle pass off together in perspiration.

will die, and yet will live with the least in winter. Hence it appears, that the taking in and passing of never so great a quantity of pabulum, with its vehicle, through a plant, will not keep it alive unless it have leaves in proportion to that quantity, as all plants have that live in winter. It cannot then be denied, that leaves are absolutely necessary to the life of a plant, and if they are, it must be either on account of their conveying something from it, or sending something to it: it is plain it cannot be only by the former, because that can be done without leaves; they must therefore be necessary by the latter.

And as the lungs would be of no benefit to an animal, if the blood, after it was secured and purified in them, were not returned to the body, as well as received from it; so the secretion made by leaves would be of no benefit to the plant, if none of the sap there secured were returned back to it; neither could the air taken in by the leaves be of any use to the rest of the plant, unless it did pass from the leaves along with the purified sap into the plant, by some vessel like the aorta. And I think that whoever proves that the air passes from the leaves into the plant, sufficiently proves the circulation of the sap, because if the sap did move always from the plant to the leaves, the air could not pass against the stream of it.

It seems that the chief arguments that give Mr. Hales a suspicion against the circulation, are taken from the quick passage of liquor from the root through the plant, and his supposing that liquor to be sap; which I think almost as unreasonable as to suppose the wine we drink and which passes out, to be blood. The more we drink, the quicker the liquor will generally pass; and the man who drank out a large vessel at one draught, and discharged it without taking his mouth from the tap until it was finished, had as quick a passage for liquor as any plant in all Mr. Hales's experiments, and yet is no proof against the circulation of the blood.

Vide Mr. Hales of *Végétation*, page 324, 325; where he says, that it is probable dew, rain, &c. are imbibed by the leaves, and are the materials of which the more subtle and refined principles are formed. And also, 'That leaves do, in some measure, the same office for the support of vegetable life, that lungs do for the support of the animal life; plants drawing through their leaves some part of their nourishment from the air.'

If this nutritive matter did enter at the excretory ducts of leaves, while the plant was in an imbibing state (as he seems to think), then they must be expelled again at the same ducts, by the force of the perspiring stream, as soon as the perspiring state returns; and thus could be of little or no use to the sap, not going far in.

Or to what purpose should the sap be depurated in the leaves, if it were not to be returned back by other vessels, like arteriæ venosæ, into the stem or stalk of a plant?

If no circulation, the sap and all other juices must pass off together, and then there would be no manner of use of the vessels of the leaves as strainers.

It would be very strange, if what is pure earth and water when it enters the roots, should be transformed to such different juices, by passing once through a plant, as from an alembic, and in so short a time.

In such case, either it must become perfect sap in the root, or else, when it first passed thence, it would not be much different from earth and water near the root, and the higher it went the more different, and the more altered it would be; but we find the sap at the bottom and top of a plant to be the same, and as full of spirit at the bottom, which could not be supposed to be made in so short a percolation, if by percolation at all.

If leaves did not perform this necessary work of succification, the lives of plants would not, in all probability, so entirely depend on the use of leaves, as they appear to do. And this is always found true (though too late) by those who kill their St. Foin, by suffering it to be indiscreetly fed by sheep: and to caution them against that injury, is the reason of my writing this chapter.

Leaves being so necessary, nature has, in all perennial plants, provided a reversionary stock of them; wherefore leaves are always formed, as Dr. Grew observes, in autumn, though they are not usually explained till the following

And is it not more probable, that the sulphureo-aerial particles which, he proves, are so plentifully in leaves, should invigorate the pure sap returning into the plant, than to invigorate only that recrementitious sap, that is just making its exit at the excretory ducts? How could this invigorate the plant, or help to nourish it.

spring, which then open and increase gradually, in proportion to the motion of the sap, and quantity of pabulum it then receives to be circulated.

These may also, though not wholly appearing out of the bud, be sufficient for the extreme small motion of life the sap of perennial plants, which drop their leaves, has in winter.

Besides these autumnal leaves of Dr. Grew's, there is another set of them formed in the spring, which appear and are explained about midsummer; these save the lives of the mulberry-trees, when the first leaves are taken off for the food of silkworms; but these second leaves alone would not suffice to purify the sap, or save the trees, if the first leaves were stripped off downwards; but as those who gather them, pull and strip them upwards, there always remain some of the tails or foot-stalks, with a little part of the leaves behind unpulled; by help of which remaining parts, the trees make a shift to live for some time, till the new leaves grew large enough: as men have been found to live (but not long I suppose) by a small part of their lungs, the rest having been wasted and dried away in consumptive or asthmatical cases.

This is certain from all experience, that no vegetable whatever can live long without leaves, but will very soon die, if the leaves are pulled off as fast as they appear.

The reason why natural grass may seem an exception to this is, that when it is fed by cattle, there is never any great quantity of it (especially of stalks) growing at once, and so less sap to be purified; and has not only a greater proportion of leaves, but also many successions of them, still ready to supply the loss of those that are eaten; and many of these leaves are so small, short, and low, that the cattle cannot come at them to bite them off close; many more also come out of the very roots of natural grass.

CHAPTER III.

OF FOOD OF PLANTS.

THE chief art of a husbandman is to feed plants to the best advantage; but how shall he do that, unless he knows what is their food? By food is meant that matter, which, being added and united to the first stamina of plants, or plantulæ, which were made in little at the creation, gives them, or rather is their increase.

It is agreed that all the following materials contribute in some manner to the increase of plants, but it is disputed which of them is that very increase or food. 1. Nitre. 2. Water. 3. Air. 4. Fire. 5. Earth.

I will not mention, as a food, that acid spirit of the air, so much talked of; since, by its eating asunder iron bars, it appears too much of the nature of aqua-fortis to be a welcome guest alone to the tender vessels of the roots of plants.

Nitre is useful to divide and prepare the food, and may be said to nourish vegetables in much the same manner as my knife nourishes me, by cutting and dividing my meat; but when nitre is applied to the root of a plant, it will kill as certainly as a knife misapplied will kill a man: which proves that nitre is, in respect of nourishment, just as much the food of plants, as white arsenic is the food of rats. And the same may be said of salts.

Water, from Van Helmont's experiment, was by some great philosophers thought to be it. But these were deceived, in not observing that water has always in its intervals a charge of earth, from which no art can free it. This hypothesis having been fully confuted by Dr. Woodward, nobody

has, that I know of, maintained it since: and to the Doctor's arguments I shall add more in the article of air.

Air, because its spring, &c., is as necessary to the life of vegetables as the vehicle of water is, some modern virtuosi have affirmed, from the same and worse arguments than those of the water-philosophers, that air is the food of plants. Mr. Bradley being the chief, if not only author, who has published this fantasie, which at present seems to get ground, it is fit he should be answered, and this will be easily done, if I can show, that he has answered this his own opinion by some or all of his own arguments.

His first is, that of Helmont, and is thus related in Mr. Bradley's General Treatise of Husbandry and Gardening, vol i. p. 36, "Who dried two hundred pounds of earth, "and planted a willow of five pounds weight in it, which he "watered with rain, or distilled water; and to secure it "from any other earth getting in, he covered it with a perforated tin cover. Five years after, weighing the tree, with "all the leaves it had borne in that time, he found it to "weigh one hundred sixty-nine pounds three ounces; but the "earth was only diminished about two ounces in the weight."

On this experiment Mr. Bradley grounds his airy hypothesis. But let it be but examined fairly, and see what may be thence inferred.

The tin cover was to prevent any other earth from getting in. This must also prevent any earth from getting out, except what entered the roots, and by them passed into the tree.

A willow is a very thirsty tree, and must have drank in five years time several tuns of water; which must necessarily carry in its interstices a great quantity of earth (probably many times more than the tree's weight*) which could not get out, but by the roots, of the willow.

* The body of an animal receives a much less increase in weight than its perspirations amount to, as Sanctorius's Static Chair demonstrates.

Therefore the two hundred pounds of earth not being increased, proves, that so much earth as was poured in with the water did enter the tree.

Whether the earth did enter to nourish the tree, or whether only in order to pass through it (by way of vehicle to the air) and leave the air behind for the augmentation of the willow, may appear by examining the matter of which the tree did consist.

If the matter remaining after the corruption or putrefaction of the tree be earth will it not be a proof, that the earth remained in it to nourish and augment it? for it could not leave what it did not first take, nor be augmented by what passed through it. According to Aristotle's doctrine, and Mr. Bradley's too, in Vol. I. p. 72, "Putrefaction resolves it again into the earth, its first principle."

The weight of the tree, even when green, must consist of earth and water. Air could be no part of it, because air being of no greater specific gravity than the incumbent atmosphere, could not be of any weight in it; therefore was no part of the one hundred sixty-nine pounds three ounces.

Nature has directed animals and vegetables to seek what is most necessary to them.

At the time when the foetus has a necessity of respiration it is brought forth into the open air, and then the lungs are filled with air. As soon as a calf, lamb, &c. is able to stand, it applies to the teat for food, without any teaching. In like manner Mr. Bradley remarks, in his Vol. I. p. 10, "That
"almost every stem and every root are formed in a bending
"manner under ground, and yet all these stems become
"straight and upright when they come above ground, and
"meet the air; and most roots run as directly downwards,
"and shun the air as much as possible."

Can any thing more plainly show the intent of nature, than this his remark, does, viz. That the air is most necessary to

the tree above the ground, to purify the sap by the leaves, as the blood of animals is depurated by their lungs? And that roots seek the earth for their food, and shun the air, which would dry up and destroy them?

No one truth can possibly contradict or interfere with any other truth; but one error may contradict and interfere with another error, viz.

Mr. Bradley and all authors, I think, are of opinion, that plants of different natures are fed by a different sort of nourishment; from whence they aver, that a crop of wheat takes up all that is peculiar to that grain; then a crop of barley all that is proper to it; next a crop of peas, and so on, until each has drawn off all those particles which are proper to it; and then no more of these grains will grow in that land, until by fallow, dung, and influences of the heavens, the earth will be again replenished with new nourishment, to supply the same sorts of corn over again. This, if true (as they all affirm it to be), would prove that the air is not the food of vegetables. For the air being in itself so homogeneous as it is, could never afford such different matter as they imagine, neither is it probable that the air could afford the wheat nourishment more one year than the ensuing year. Or that the same year it should nourish barley in one field, wheat in another, peas in a third; but that if barley were sown in the third, wheat in the first, peas in the second, all would fail. Therefore this hypothesis of air for food interferes with and contradicts this doctrine of necessity of changing sorts.

I suppose, by air, they do not mean dry particles of earth, and the effluvia which float in the air, the quantity of these is too small to augment vegetables to that bulk they arrive at. By that way of speaking they might more truly affirm this of water because it must be like to carry a greater quantity of earth than air doth, in proportion to the difference of their different specific weights; water being about 800 times heavier than air, is

likely to have 800 times more of that terrestrial matter in it; and we see this is sufficient to maintain some sorts of vegetables, as aquatics. But the air, by its change of effluvia, &c., is never able to maintain or nourish any plant; for as to the sedums, aloes, and all others that are supposed to grow suspended in the air, it is a mere fallacy; they seem to grow, but do not; since they constantly grow lighter, and though their vessels may be somewhat distended, by the ferment of their own juices, which they received in the earth, yet, suspended in air, they continually diminish in weight (which is the true increase of a plant) until they grow to nothing. So that this instance of sedums, &c. which they pretend to bring for proof of this their hypothesis, is alone a full confutation of it.

Yet if granted, that air would nourish some vegetables by the earthy effluvia, &c., which it carried with it*, even that would be against them, not for them.

They might as well believe that martins and swallows are nourished by the air because they live on flies and gnats, which they catch therein; this being the same food which is found in the stomach of the cameleon.

If, as they say, the earth is of little other use to plants but to keep them fixed and steady, there would be little or no difference in the value of rich and poor land, dunged or undunged; for one would serve to keep plants fixed and steady very near, if not quite, as well as the other.

If water or air were the food of plants, I cannot see what necessity there should be of dung or tillage.

4. Fire. No plant can live without heat, though different

* This is meant of dry earth, by its lightness (when pulverized extremely fine) carried in the air without vapour: for the atmosphere, consisting of all the elements, has earth in considerable quantity, mixed with water; but a very little earth is so minutely divided, as to fly therein pure from water; which is its vehicle there for the most part.

degrees of it be necessary to different sorts of plants. Some are almost able to keep company with the salamander, and do live in the hottest exposures of the hot countries. Others have their abode with fishes, under water, in cold climates; for the sun has his influence, though weaker, upon the earth covered with water, at a considerable depth, which appears by the effect the vicissitudes of winter and summer have upon the subterraqueous vegetables.

But that fire is the food of plants, I do not know any author has affirmed, except Mr. Lawrence; who says, 'They are true fire-eaters.' And even he does not seem to intend, that this expression of his should be taken literally; yet, if he had meant it in the plain sense the words import, perhaps he might have been much nearer the truth than Mr. Bradley with his air. For if fire be nothing else but the minutest parts of terrestrial matter, put into a violent motion, then those minute parts out of that motion are the same matter as when in it; and these being the true nourishment of plants, that and fire differ in nothing but the motion.

Fire is a fluid *sui generis*; but that it pervades all bodies, and there remains latent; if excited by violence is hot; if at rest may be cold, being against the essential property of fire: that notion cannot pervade the skull of a peasant to make him believe fire can ever be cold.

But if we define fire to be the action of burning, not the matter which burns, then fire will be as different from the food of plants as air is.

Indeed the true food of plants may be also the fuel of fire, which is so greedy of that food as to carry it all away that comes within reach of the flames; and I know no way by which the earth can be divested of its vegetative particles, but by actual fire, or the roots of plants.

Though every heat is said to be a different degree of fire, yet we may distinguish the degrees by their different effects.

Heat warms, but fire burns ; the first helps to cherish, the latter destroys, plants.

5. Earth. That which nourishes and augments a plant, is the true food of it .

Every plant is earth, and the growth and true increase of a plant is the addition of more earth.

Nitre (or other salts) prepares the earth, water and air move it, by conveying and fermenting it in the juices, and this motion is called heat.

When this additional earth is assimilated to the plant, it becomes an absolute part of it.

Suppose water, air, and heat, could be taken away, would it not remain to be a plant, though a dead one ?

But suppose the earth of it taken away, what would then become of the plant ? Mr. Bradley might look long enough after it, before he found it in the air amidst his specific or certain qualities.

Besides, too much nitre (or other salts) corrodes a plant ; too much water drowns it ; too much air dries the roots of it ; too much heat (or fire) burns it ; but too much earth, a plant never can have, unless it be therein wholly buried ; and in that case it would be equally misapplied to the body, as air or nitre would be to the roots.

Too much earth, or too fine, can never possibly be given to roots ; for they never receive so much of it as to surfeit the plant, unless it be deprived of leaves, which, as lungs, should purify it.

And earth is so surely the food of all plants, that with the proper share of the other elements, which each species of plants requires, I do not find but that any common earth will nourish any plant.

The only difference of soil (except the richness) seems to be the different heat and moisture it has ; for if those be rightly adjusted, any soil will nourish any sort of plant. For

let thyme and rushes change places, and both will die ; but let them change their soil, by removing the earth wherein the thyme grew, from the dry hill down to the watery bottom, and plant rushes therein ; and carry the moist earth, wherein the rushes grew, up to the hill ; and there thyme will grow in the earth, that was taken from the rushes ; and so will the rushes grow in the earth that was taken from the thyme ; so that it is only more or less water that makes the same earth fit either for the growth of thyme or rushes.

As I have said in my Essay, that a soil being once proper to a species of vegetables, it will always continue to be so. It must be supposed that there be no alteration of the heat and moisture of it ; and that this difference, I mean, is of its quality of nourishing different species of vegetables, not of the quantity of it. Which quantity may be altered by diminution or superinduction.

So for heat ; our earth when it has in the stove the just degree of heat, that each sort of plant requires, will maintain plants brought from both the Indies.

Plants differ as much from one another in their various degrees of heat and moisture, as a fish differs from a salamander.

Indeed misletoe will not live upon earth, until it be first altered by the vessels of a tree, and therein is as nice in food as an animal.

There is no need to have recourse to transmutation ; for whether air or water, or both, are transformed into earth or not, the thing is the same, if it be earth when the roots take it ; and we are convinced that neither air nor water alone, as such, will maintain plants.

I can find no clear proof of the reality of transmutation : the only one that I know is that Sir Isaac offers, for water being transmuted into earth, which he quotes from Mr. Boyle ; but that experiment was made by a friend of Mr. Boyle, and

Mr. Boyle himself was so far from believing it a real transmutation that he gave a reason to prove the impossibility of it.

The substance of the experiment here follows : viz., An ounce of rain-water being distilled near two hundred times, there remained six drachms of white powder, and a considerable quantity of water left behind ; which powder, Mr. Boyle suspects might be partly obtained from the glass vessel wherein it was distilled rather than from the ounce of water, neither the glass nor the remaining water having been weighed ; for if the glass were diminished (which could not be known but by weighing), or if the remaining water were above two drachms, it would have been a demonstration, that all the powder did not proceed from the ounce of water : and I suppose that some part of the water (being volatile, and passing pores that scarce any other fluid does) might get off through the hot glass, or otherwise, in such a number of distillations ; and that then there must be (for supply of that loss) some adventitious matter in the six drachms of powder, though the water that remained should weigh but just two drachms.

And this powder must consist of parts of the glass, and of such matter as the distillations had separated from the pores of the water.

Mr. Boyle thinks, that “ if water be truly an homogeneous body, it is difficult, if not impossible, to conceive that it can be transmuted : for how (says he) can the bare convention of the parts of a fluid into a concrete, alter the specific gravity ? ” Which is as much as to say, that water being specifically lighter, cannot become powder, which is specifically heavier : and water after distillation (being more pure, though never perfectly pure) always becomes specifically lighter than before ; and the matter that is left in the still, heavier ; water changing its specific gravity in proportion to the degree of its purity.

And water considered abstractedly from the charge of other matter (chiefly earth, which it carries in its pores or interstices) is at this time, I think, generally agreed to be homogeneous, consisting of extremely small, smooth, hard, porous, spherical particles of equal diameters, incompressible, void of taste, and having no quality that renders a body heterogeneous.

But indeed (as far as I am informed), Mr. Boyle and his friend, at the time this experiment was made, did not at all distinguish any difference between the particles (or corpuscles) of water and the other matter contained in its pores (mistaking the vehicle for the thing carried, than which, nothing can be more different); and therefore they, as they seem to consider both only confusedly, could have no distinct idea of either; and thus this experiment proves nothing in favour of transmutation. And yet it has deceived some who, one would think, should have examined more narrowly into the matter than to mistake a separation of earth from water for a change of water into earth.

But this will cease to be a wonder, when we see what that miracle of a man Sir Isaac Newton brings for argument to countenance an hypothesis of his.

“Water (he says) is by heat converted into vapour, which
“is a kind of air, and by cold into ice, which is a stone; and
“this stone is convertible into water again by heat, as vapour
“is by cold.”

But I believe the learned will now subscribe to the opinion, that water, when carried in the air, under the form (or rather name) of vapour, is not air of any kind; and that when it is under the form of ice it is not really stone; it never having all the properties of air, or of stone.

His other instances are of like validity; for an egg being turned into an animal, is no more a real transmutation, than that the royal oak was transmuted into a prince, when he was

taken out of it ; or that a man's house, when he is gone abroad is transmuted into a man.

A maggot is a little fly enveloped in a thin skin, which, as a garment, hides the wings and legs ; and continues to be the same fly when uncovered, as a man is the same man when his garments are off, as when on ; the fly grows bigger, and so does a boy when he becomes a man, but still continues to be the same person, without any real transmutation, unless he should become infallible.

Sir Isaac says, that “ all birds, beasts, fishes, insects, “ trees, and plants, grow and increase out of water, and “ aqueous and saline tinctures : and on putrefaction all of “ them revert into water or an aqueous liquor again.”

Also in treating of Comets, he says, “ They seem “ necessarily requisite, from whose condensed exhalations “ and vapours all that moisture, which is consumed in “ vegetation and putrefaction, and turned into dry earth, “ may by degrees be continually resupplied and recruited ; “ for all vegetables do entirely grow and increase from “ liquors : and then, as to their greatest part, do turn, by “ putrefaction into dry earth, and a slime perpetually is “ precipitated to the bottom of putrefying liquors.

“ From hence the quantity, or bulk of dry earth, must “ continually increase, and the liquors, or moisture of our “ globe continually decrease, and, at last, be quite evapor- “ ated and lost, if they had not as continual a supply “ from some part or other of the universe.”

Now I must beg leave to confess, that I can see no force in these arguments, either for the transmutation of water, or any such necessity of comets.

And even though transmutation should be supposed (which by no means can be granted), yet no such consequence of the decrease of water on our globe can be drawn from Sir Isaac's argument, but the contrary.

For he says, that birds, beasts, fishes, insects, trees, and plants, on putrefaction, all of them revert into water, or an aqueous liquor again.

How then does it follow, that the water of our globe is ever consumed or diminished, or that it can want any supply of moisture?

The water brought to the land in vapour from the sea, we see returns by the rivers to the sea again; all of it, either before it in part enters other bodies, or after it returns out of them, except such of it that is carried back in vapour.

The smoothness, hardness, and other properties of the corpuscles of water seem to render them incapable of the cohesion which is necessary for incorporating with earth or other bodies, yet where these corpuscles are so very few in number as to lose their fluidity, some of them may rest in other bodies for a time, but afterwards either slide out, or are expelled by heat; or else more of the same corpuscles come to them, and restore them to fluidity: for it is not likely they should remain always confined by other bodies since their slipperiness, sphericity, and equal smallness of their diameters enables them to pass the pores of gold, and where one corpuscle passes, all may pass; some sooner, some later, as there are innumerable degrees of dryness and moisture.

A violin is said to require fourscore years after the making ere it obtains that degree of dryness that gives its perfection of sound: and after all, cannot be supposed perfectly dry, whilst it has pores permeable to the aqueous vapour that floats in the ambient air: and some such pores will it have until time (that devourer of things) has destroyed its texture, and reduced it to the very same earth, that water carried in at the vegetable roots; which earth, will then again become as dry as when water seized it, and took it up for the trees out of which the violin was made. Green wood would grow drier but not lighter, if water were transmuted in it.

I can see no reason to think that any part of the pure element (or corpuscles) of water is consumed upon vegetation; but rather, that the same water which served for the production, &c., of one plant, may afterwards as well serve for other plants successively, and for all other its uses as long as the world shall last: nor do I think there is any diminution of that element on our globe since it was first created; for as much water going out of some bodies as goes into others, keeps the quantity the same, and the balance even betwixt it and earth, without a necessity of any supply from comets.

From Sir Isaac's transmutation-arguments we may learn, that a man never ought to depend entirely upon his own for support of his own hypothesis.

Sir Isaac's death seems scarce a stronger proof of his being human, than the whole contexture of these arguments is. To favour transmutation, he says, the bodies of animals and plants, on putrefaction, revert into water or an aqueous liquor again: but in favour of the necessity of comets, on account of the consumption of water, he says, that those bodies turn by putrefaction into dry earth!

It is difficult for the ignorant to understand the terms of the learned, but, by this aqueous liquor, I understand a mixture of earth and water, and suppose a saline tincture is only a term of the learned of the same signification; but that a liquor and dry earth should be the same thing, is what, I own, I can by no means comprehend.

It is certain that by the consumption of water, Sir Isaac does not mean the annihilation of it, but that it was transmuted into dry earth.

If this were so, an animal or vegetable would weigh as much when putrefaction had reduced it to dry earth as it would when living.

Yet, we find, that this remaining dry earth is only a very small part of the weight of the living animal or plant.

What then becomes of the remainder of the whole weight whereof the living bodies consisted?

Why, I suppose it goes the same way that the aqueous part of the nourishment of a living body goes, after a short stay therein, viz., it either perspires into the atmosphere, or sinks into the ground, all except what remains for increase of the bodies, which is but a very inconsiderable part of the water, and none at all when the bodies are at their full growth, or declining.

I cannot conceive how the liquors or moisture of our globe, should ever be all or in any part lost by being evaporated, unless it should fly off to some other part of the universe, instead of being continually supplied from thence.

Were it not for evaporation, the watery element would be useless to vegetables and animals, except to such as live with salt-water in the sea; for neither springs, nor rivers, nor other fresh water would be found on our globe: or, if so great a quantity of liquor or moisture should be transmuted into dry earth, and resupplied from any other part of the universe, the bulk and diameter of the earth must continually increase; and what consequences such an increase might have is above my inquiry; but I suppose the attraction to the sun would continually increase in proportion to the access of matter continually coming to our globe.

But what alterations such increased bulk and weight might cause in the motion or orbit of this our planet astronomers only can judge; and I am not informed that any of them have ever observed any increase of the earth's diameter, &c.

As far as this hypothesis of Sir Isaac's relates to agriculture I think we need not fear it, so as to abstain from raising as many vegetables as we can; there being no danger of their consuming the water they imbibe, for in general we have rather too much water than too little; and it is observed, that three or four wet summers make a scarcity, and many dry

ones make a plenty in our islands: and if it were not the same in other countries, wet summers would not cause the price of corn here to be treble what it is reduced to by dry summers.

We have therefore more to fear than hope from the tails of comets, because the matter of them mixing with our atmosphere would be likely to bring both famine and pestilence amongst the inhabitants of our earth; the former by the aqueous part, and the latter by the noxious terrene exhalations of which, as well as of watery vapours, the tails of comets are supposed to consist.

It is allowed that the fine particles of earth, &c., brought to the ground by water, enrich the soil; but yet much water in the growing season is very pernicious to corn, though not to weeds, they being naturally adapted to the soil, some of them aquatics, some amphibious, and others that cannot bear so much water, grow on such lands whereon the water did not long remain, but sinks down or runs off very soon.

I may add, that if the intense heat of actual fire, in almost 200 distillations be not able to break the corpuscles of water, or destroy their texture, so as to change that element into earth, or any other matter, there can be no possibility of such a transmutation from that very small degree of heat which water suffers by the weak ferment it encounters in the vessels of plants and animals.

These kind of metamorphoses may properly enough be considered in dissertations purely concerning matter, and to discover what the component particles of earth are; but not at all necessary to be known, in relation to the maintaining of vegetables.

CHAPTER IV.

OF PASTURE OF PLANTS.

CATTLE feed on vegetables that grow upon the earth's external surface ; but vegetables themselves first receive, from within the earth, the nourishment they give to animals.

The pasture of cattle has been known and understood in all ages of the world, it being liable to inspection ; but the pasture of plants, being out of the observation of the senses, is only to be known by disquisitions of reason, and has (for aught I can find) passed undiscovered by the writers of husbandry.*

The ignorance of this seems to be one principal cause, that agriculture, the most necessary of all arts, has been treated of by authors more superficially than any other art whatever.

The food, or pabulum, of plants being proved to be earth, where and whence † they take that, may properly be called their pasture.

This pasture I shall endeavour to describe.

* When writers of husbandry, in discoursing of earth and vegetation, come nearest to the thing, that is, the pasture of plants, they are lost in the shadow of it, and wander in a wilderness of obscure expressions, such as magnetism, virtue, power, specific quality, certain quality, and the like, wherein there is no manner of light for discovering the real substance ; but we are left by them more in the dark to find it, than roots are when they feed on it. And when a man, no less sagacious than Mr. Evelyn, has traced it through all the mazes of the occult qualities, and even up to the metaphysics, he declares he cannot determine whether the thing he pursues be corporeal or spiritual.

† By the pasture is not meant the pabulum itself, but the superficies from whence the pabulum is taken by roots.

It is the inner (or internal) superficies* of the earth; or, which is the same thing, it is the superficies of the pores, cavities, or interstices of the divided parts of the earth, which are of two sorts, viz., natural and artificial.

By nature, the whole earth (or soil) is composed of parts; and if these had been in every place absolutely joined, it would have been without interstices, or pores, and would have had no internal superficies, or pasture for plants; but, since it is not so strictly dense†, there must be interstices at all those places where the parts remain separate and divided.

These interstices, by their number and largeness, determine the specific gravity (or true quantity) of every soil, the larger they are, the lighter is the soil; and the inner superficies is commonly the less.

The mouths, or lacteals, being situate, and opening in the convex superficies of roots, they take their pabulum, being fine particles of earth, from the superficies of the pores, or cavities, wherein the roots are included.

* This pasture of plants never having been mentioned or described by any author that I know of, I am at a loss to find any other term to describe it by, that may be synonymous, or equipollent to it; therefore, for want of a better, I call it the inner, or internal superficies of the earth, to distinguish it from the outer, or external superficies, or surface whereon we tread.

Inner, or internal superficies, may be thought an absurd expression, the adjective expressing something within, and the substantive seeming to express only what is without it; and, indeed, the sense of the expression is so; for the vegetable pasture is within the earth, but without (or on the outsides of) the divided parts of the earth.

And, besides, superficies must be joined with the adjective inner (or internal) when it is used to describe the inside of a thing that is hollow, as the pores and interstices of the earth are.

The superficies, which is the pasture of plants, is not a bare mathematical superficies, for that is only imaginary.

† For were the soil as dense as glass, the roots, or vegetables (such as our earth produces) would never be able to enter its pores.

And it is certain, that the earth is not divested or robbed of this pabulum, by any other means than by actual fire, or the roots of plants.

For when no vegetables are suffered to grow in a soil, it will always grow richer. Plough it, harrow it, as often as you please; expose it to the sun in horse-paths all the summer, and to the frost of the winter; let it be covered by water at the bottom of ponds or ditches, or if you grind dry earth to powder, the longer it is kept exposed, or treated by these or any other method possible (except actual burning by fire), instead of losing, it will gain the more fertility.

These particles, which are the pabulum of plants, are so very minute* and light, as not to be singly attracted to the earth, if separated from those parts to which they adhere†, or with which they are in contact (like dust to a looking-glass, turn it upwards, or downwards, it will remain affixed to it), as these particles do to those parts, until from thence removed by some agent.

A plant cannot separate these particles from the parts to which they adhere, without the assistance of water, which helps to loosen them.

* As to the fineness of the pabulum of plants, it is not unlikely that roots may insume no grosser particles than those on which the colours of bodies depend; but to discover the greatness of those corpuscles, Sir Isaac Newton thinks, will require a microscope that with sufficient distinctness can represent objects five or six hundred times bigger than at a foot distance they appear to the naked eye.

My microscope indeed is but a very ordinary one, and when I view with the liquor newly imbibed by a fibrous root of a mint, it seems more limpid than the clearest common water, nothing at all appearing in it.

† Either roots must insume the earth, that is, their pabulum, as they find it in whole pieces, having entire superficies of their own, or else such particles as have not entire superficies of their own, but want some part of it, which adheres to, or is part of the superficies of larger particles, before they are separated by roots. The former they cannot insume (unless contained in water), because they would fly away at the first pores that were open: *ergo*, they must insume the latter,

And it is also probable, that the nitre of the air may be necessary to relax this superficies, to render the prolific particles capable of being thence disjoined; and this action of the nitre seems to be what is called impregnating the earth.

Since the grosser vegetable particles, when they have passed through a plant, together with their moist vehicle, do fly up into the air invisibly, it is not likely they should, in the earth, fall off from the superficies of the pores by their own gravity; and if they did fall off, they might fly away as easily before they entered plants as they do after they have passed through them; and then a soil might become the poorer,* for all the culture and stirring we bestow upon it, though no plants were in it, contrary to experience.

It must be owned, that water does ever carry in its interstices particles of earth, fine enough to enter roots; because I have seen, that a great quantity of water (in my experiments) will pass out of roots set in rain-water; and it is found that water can never be, by any art, wholly freed from its earthy charge; therefore it must have carried in some particles of earth along with it; but yet, I cannot hence conclude, that the water did first take these fine particles from the aforesaid superficies. I rather think that they are exhaled, together with very small pieces to which they adhere, and in the vapour divided by the aerial nitre, and when the vapour is condensed, they descend with it to replenish the pasture of plants; and that these do not enter entire into roots, neither does any other of the earthy charge that any water contains; except such fine particles which have already passed through the vegetable vessels, and been thence exhaled.

* But we see it is always the richer by being frequently turned and exposed to the atmosphere; therefore plants must take all their pabulum from a superficies of parts of earth; except what may perhaps be contained in water fine enough to enter roots entire with the water.

This conjecture is the more probable, for that rain-water is as nourishing to plants set therein, as spring-water, though the latter have more earth in it; and though spring-water have some particles in it, that will enter entire into roots, yet we must consider, that even that water may have been many times exhaled into the air, and may have still retained a great quantity of vegetable particles, which it received from vegetable exhalations in the atmosphere, though not so great a quantity as rain-water, that comes immediately thence.

These, I have to do with, are the particles which plants have from the earth, or soil; but they have also fine particles of earth from water, which may impart some of its finest charge to the superficies of roots, as well as to the superficies of the parts of the earth*, which makes the pasture of plants.

Yet it seems, that much of the earth contained in the clearest water is there in too large parts to enter a root; since we see that in a short time the root's superficies will in the purest water be covered with earth, which is then formed into a terrene pasture, which may nourish roots; but very few plants will live long in so thin a pasture as any water affords them. I cannot find one, as yet, that has lived a year without some earth having been added to it.

And all aquatics, that I know, have their roots in the earth, though covered with water.

The pores, cavities, or interstices of the earth, being of two sorts, viz., natural and artificial; the one affords the natural, the other the artificial pasture of plants.

The natural pasture alone will suffice to furnish a country with vegetables for the maintenance of a few inhabitants, but if agriculture were taken out of the world, it is much to be feared, that those of all populous countries, especially to-

* If water does separate, and take any of the mere pabulum of plants from the soil, it gives much more to it.

wards the confines of the frigid zones (for there the trees often fail of producing fruit), would be obliged to turn anthropophagi, as in many uncultivated regions they do, very probably for that reason.

The artificial pasture of plants is that inner superficies which is made from dividing the soil by art.

This does, on all parts of the globe where used, maintain many more people than the natural pasture*; and in the colder climates, I believe it will not be extravagant to say, ten times as many: or, that in case agriculture were a little improved (as I hope to show is not difficult to be done), it might maintain twice as many more yet, or the same number better.

The natural pasture is not only less than the artificial, in an equal quantity of earth, but also that little consisting in the superficies of pores, or cavities, not having a free commu-

* The extraordinary increase of St.-Foin, clover, and natural grass, when their roots reach into pulverised earth, exceeding the increase of all those other plants of the same species (that stand out of the reach of it), above one hundred times, show how vastly the artificial pasture of plants exceeds the natural. A full proof of this difference (besides very many I have had before), was seen by two intervals in the middle of a poor field of worn out St.-Foin, pulverised in the precedent summer, in the manner described in p. . Here not only the St.-Foin adjoining to these intervals recovered its strength, blossomed, and seeded well, but also the natural grass amongst it was as strong, and had as flourishing a colour, as if a dung-heap had been laid in the intervals: also many other weeds came out from the edges of the unploughed ground, which must have lain dormant a great many years, grew higher and larger than ever were seen before in that field; but above all, there was a weed amongst the St.-Foin, which generally accompanies it, bearing a white flower; some call it white-weed, others, ladies'-bedstraw. Some plants of this that stood near the intervals, were, in the opinion of all that saw them, increased to a thousand times the bulk of those of the same species, that stood in the field three feet distant from such pulverised earth.

Note. These intervals were each an hundred perch long, and had each in them a treble row of barley, very good. The reason I take to be this, That the land having lain still several years after its artificial pasture was lost, whereby all the plants in it having only the natural pasture to subsist on, became so extremely small and weak, that they were not able to

incation* with one another, are less pervious to the roots of all vegetables, and which require a greater force to break through their partitions; by that means roots, especially of weak plants, are excluded from many of those cavities, and so lose the benefit of them.

But the artificial pasture consists in superficies of cavities, that are pervious to all manner of roots, and that afford them free passage and entertainment in and through all their recesses. Roots may here extend to the utmost without meeting with any barricadoes in their way.

The internal superficies, which is the natural pasture of plants, is like the external superficies, or surface of the earth, whereon is the pasture of cattle; in that it cannot be enlarged without addition of more surface taken from land adjoining to it, by enlarging its bounds or limits.

But the artificial pasture of plants may be enlarged without any addition of more land, or enlarging of bounds, and this by division only of the same earth.

And this artificial pasture may be increased in proportion to the division of the parts of earth, whereof it is the superficies, which division may be mathematically infinite; for an atom is nothing; neither is there a more plain im-

exhaust the land of so great a quantity of the (vegetable) nourishing particles as the atmosphere brought down to it.

And when by pulverisation the artificial pasture came to be added to this natural pasture, not much exhausted, and nothing at all suffered to grow out of it for above three-quarters of a year, it became rich enough, without any manure, to produce this extraordinary effect upon the vegetables, whose roots reached unto it. How long this effect may continue is uncertain; but I may venture to say, it will continue until the exhaustion by vegetables doth overbalance the descent of the atmosphere and the pulverisation.

And what I have said of any one species of plants in this respect may be generally applied to the rest.

* None of the natural vegetable pasture is lost or injured by the artificial, but, on the contrary, it is mended by being mixed with it, and by having a greater communication betwixt pore and pore.

possibility in nature, than to reduce matter to nothing by division or separation of its parts.

A cube of earth of one foot has but six feet of superficies. Divide this cube into cubical inches, and then its superficies will be increased twelve times, viz., to seventy-two superficial feet. Divide these again in like manner and proportion; that is, divide them into parts that bear the same proportion to the inches as the inches do to the foot; and then the same earth, which had at first no more than six superficial feet, will have eight hundred sixty-four superficial feet of artificial pasture, and so is the soil divisible, and this pasture increasible, *ad infinitum*.

Poor land does not afford an internal superficies so well stocked with these fruitful particles, as rich land does, but this we may compensate by *dividing* it more; to the end that what this artificial pasture wants in quality, may, by division, be made up in quantity.

The common methods of dividing the soil are these, viz., by *dung*, by *tillage*, or by both*.

* For *vis unita fortior*.

CHAPTER V.

OF DUNG.

ALL sorts of dung and compost contain some matter which, when mixed with the soil, ferments therein; and by such ferment dissolves, crumbles, and divides the earth very much. This is the chief and almost only use of dung: for as to the pure earthy part of it, the quantity is so very small, that, after a perfect putrefaction, it appears to bear a most inconsiderable proportion to the soil it is designed to manure, and therefore, in that respect, is next to nothing.

Its fermenting quality is chiefly owing to the salts wherewith it abounds; but a very little of this salt, applied alone to a few roots of almost any plant, will (as in my mint-experiments it is evident common salt does) kill it.

This proves, that its use is not to nourish, but to dissolve, *i. e.*, divide the terrestrial matter, which affords nutriment to the mouths of vegetable roots.

It is, I suppose, upon the account of the acrimonious fiery nature of these salts that the florists have banished dung from their flower-gardens.

And there is, I am sure, much more reason to prohibit the use of dung in the kitchen-garden, on account of the ill taste it gives to esculent roots and plants, especially such dung as is made in great towns.

It is a wonder how delicate palates can dispense with eating their own and their beasts ordure, but a little more putrefied and evaporated; together with all sorts of filth and nastiness, a tincture of which those roots must unavoidably receive that grow amongst it.

Indeed, I do not admire, that learned palates, accustomed to the *gout* of silphium, garlic, *la chair venée*, and mortified venison, equalling the stench and rankness of this sort of city muck, should relish and approve of plants that are fed and fattened by its immediate contact.

People who are so vulgarly nice as to nauseate these modish dainties, and whose squeamish stomachs even abhor to receive the food of nobles, so little different from that wherewith they regale their richest gardens, say, that even the very water wherein a rich garden cabbage is boiled, stinks; but that the water wherein a cabbage from a poor undunged field is boiled, has no manner of unpleasant savour; and that a carrot bred in a dunghill, has none of that sweet relish which a field-carrot affords.

There is a like difference in all roots nourished with such different diet.

Dung not only spoils the fine flavour of these our eatables, but inquinates good liquor. The dung vineyards in Languedoc produce nauseous wine, from whence there is a proverb in that country, that poor people's wine is best, because they carry no dung to their vineyards.

Dung is observed to give great encouragement to the production of worms; and carrots in the garden are much worm-eaten, when those in the field are free from worms.

Dung is the putrefaction of earth after it has been altered by vegetable or animal vessels.

Vegetable dung, unless the vegetable be buried alive in the soil, makes a much less ferment in it, and consequently divides it less than animal dung does.

But if the dung be thoroughly ventilated and putrefied before it be spread on the field (as I think all the authors I have read direct) so much of its salts will be spent in fermenting the dung itself, that little of them will remain to ferment the soil, and the farmer who might dung one acre in

twenty, by laying on his dung whilst fully replete with vigorous salts, may (if he follow these writers' advice to a nicety) be forced to content himself with dunging one acre in a hundred.

This, indeed, is good advice for gardeners, for making their stuff more palatable and wholesome, but would ruin the Virgilian farmer, who could have no more dung than what he could make upon his arable farm.

For every sort of dung, the longer time it ferments without the ground, the less time it has to ferment in it, and the weaker its ferment will be.

The reason given for this great diminution of dung is, that the seeds of weeds may be rotted and lose their vegetating faculty; but this would be of little purpose, if, according to the opinion of *Equivocus*, and the lowest degree of the Virgilian vulgar, weeds sprung up naturally from the soil by equivocal generation.

This I am certain by demonstration, that let a dunghill remain three years unmoved, though its bulk be vastly diminished in that time, and its best quality lost, charlock-seed will remain sound in it, and stock the land whereon it is laid; for that ferment which is sufficient to consume the virtue of the stercoraceous salts, is not sufficient to destroy the vegetative virtue of charlock-seeds, nor (I believe) of many other sorts of weeds.

But the dung of vegetables is much more wholesome for the use of edible roots and plants than that of animals is.

The very effluvia of animal bodies, sent off by perspiration, are so noxious as to kill the animal that emits them, if confined to receive them back in great quantity, by breathing in an air replete with them; which appears from the soon dying of an animal shut up in a receiver full of air. Yet this seems to be most harmless of all the sorts of animal-excrements the air can be infected with. How noxious then must be the more foetid steams of ordure!

If a catalogue were published of all instances from charnel-houses, of cemeteries, and of the pestiferous effects which have happened from the putrefaction of dead bodies after great battles, even in the open air, nobody, I believe, would have a good opinion of the wholesomeness of animal-dung; for if a great quantity do so infect the air, it is likely a less may infect it in proportion to that less quantity.

In great cities, the air is full of these effluvia, which in hot climes often produce the pestilence; and in cold climes, people are generally observed to live a less time, and less healthfully in cities, than in the country; to which difference, it is likely, that the eating unwholesome gardenage may contribute.

This dung is a fitter food for venomous creatures* than for edible plants; and it is, no doubt, upon account of this that dunged gardens are so much frequented by toads, which are seldom or never seen in the open, undunged fields.

Some have lost their lives by toads being accidentally boiled in the folds of a loaf-cabbage; others poisoned by their only fixing their claws on their arm. A mountebank, to show the energy of its antidotes, used to eat part of a toad on his stage, and cure himself by his medicines; but I was told by one that once saw him in his chamber, after eating too large a dose of the poison, or else delaying too long the application of his remedy, in such a dismal condition that his life was despaired of, though with much difficulty, and some time, he recovered.

And notwithstanding what some authors have said of the innoxiousness of this animal, these and other instances persuade me, that nature did not give most people such an aversion to it in vain. It may not be mortal to every human body, since I am told of a man that has eaten several toads without any apparent injury to him; but I believe most who

* Mr. Evelyn says, that dung is the nurse of vermin.

shall try the experiment will be forced to confess, that what is one man's meat is another's poison.

What can we say, then, to the salubrity of those roots themselves, bred up and fattened amongst these toads and corruption? The leaves, indeed, are only discharging some of the filth when we eat them; but the roots have that unsavoury, infected food in their very mouths, when we take them for our nourishment.

But though dung be, upon these and other accounts, injurious to the garden, yet a considerable quantity of it is so necessary to most corn-fields, that without it little good can be done by the whole husbandry.

But though dung is so necessary in the old Virgilian, raftering, and *sat-erit* husbandry, yet to most sorts of land used in the old and new pulverising husbandry, it is not necessary; as it appears by mine, and by the experience of all farmers, who, being emancipated from Virgilian principles, have made proper trials: they find, as well as I, that dung may be supplied by an increase of tillage.

That dung may be useful when properly applied, I believe was never denied by any author, though I have been accused of it; but I cannot be justly charged with being the first who has thought it not to be absolutely necessary, since we learn from Hesiod (who mentioned nothing of it in his *Georgics*) that the ancient Greeks carried on their husbandry without stercoration.

Dung is not injurious to the fields*, being there in less proportion; and the produce of corn is the grain. When the leaves have done their utmost to purify the sap, the most refined part is secerned to be yet further elaborated by pecu-

* Such plants as cabbages, turnips, carrots, and potatoes, when they are designed only for fattening of cattle, will not be injured by dung, tillage, and hoeing altogether, which will make the crops the greater, and the cattle will like them never the worse.

liar organs; then, by the vessels of the blossoms, it is become double-refined for the nourishment of the grain, which is, therefore, more pure from dung, and more wholesome, than any other part of the plant that bears it.

And common tillage alone is not sufficient for many sorts of corn, especially wheat, which is the king of grains.

Very few fields can have the conveniency of a sufficient supply of dung, to enable them to produce half the wheat those will do near cities, where they have plenty of it.

The crop of twenty acres will scarcely make dung sufficient for one acre, in the common way of laying it on.

The action of the dung's ferment affords a warmth* to the infant plants in their most tender state, and the most rigorous season.

But it is hard to know how long the warmth of this ferment lasts, by reason of the great difficulty to distinguish the very least degree of heat from the very least degree of cold.

Water in wells and springs is not warmer in winter than in summer; it only seems to be so, because our sense of feeling is differently affected by touching it, as our hands and the air are colder in winter than in summer, to a greater degree than subterraneous water is.

For want of taking notice of that vulgar mistake, *Equivocus* asserts, that earth is warmer in winter than in summer.

Under the name of dung, we may also understand whatever ferments with the earth, except fire, such as green vegetables covered in the ground, &c.

* But though dung, in fermenting, may have a little warmth, yet it may, sometimes, by letting more water enter its hollowness, be in a frost much colder than undunged pulverised earth; for I have seen wheat-plants in the winter die in the very spits of dung, when undunged drilled wheat adjoining to it, planted at the same time, has flourished all the same winter; and I could not find any other reason for this but the hollowness of the dung, and yet it seemed to be well rotted.

As to the difference of the quantity of artificial pasture made by dung without tillage, and that made by tillage without dung, the latter is many times greater, of which I had the following proof. An unploughed land, wherein a dung-hill had lain for two or three years, and being taken away was planted with turnips; at the same time a tilled land, contiguous thereto, was drilled with turnips, and horse-hoed; the other, being hand-hoed, prospered best at the first, but at last did not amount to the fifth part of the tilled and horse-hoed in bigness nor in crop. The benefit of the dung and hand-hoe was so inconsiderable, in comparison of the plough and hoe-plough; the little quantity of artificial pasture raised to the other, was only near the surface, and did not reach deep enough to maintain the turnips, until they arrived at the fifth part of the growth of those of which the artificial pasture reached to the bottom of the staple of the land.

A like proof is, that several lands of turnips drilled on the level, at three-feet rows, ploughed and doubly dunged, and also horse-hoed, did not produce near so good a crop of turnips as six-feet ridges adjoining, horse-hoed, though no dung had been laid thereon for many years. There was no other difference than that the three-feet rows did not admit the hoe-plough to raise half the artificial pasture, as the six-feet rows did. The dung ploughed into the narrow intervals before drilling, could operate no further, with any great effect, than the hoe-plough could turn it up, and help it in its pulverisation.

Dung, without tillage, can do very little; with some tillage does something; with much tillage pulverises the soil in less time than tillage alone can do; but the tillage alone, with more time, can pulverise as well.

This the experiments of artificially pulverising of the poorest land, as they are related by Mr. Evelyn, fully prove.

And these experiments are the more to be depended on, as they are made, both in England and Holland, by persons of known integrity.

This truth is also further confirmed by those authors who have found that highway dust alone is a manure preferable to dung. And all these pulverisations being made by attrition or contusion, why should not our instruments of pulverisation in time reduce a sufficient part of the staple of a dry friable soil, to a dust equal to that of a highway ?

The common proportion of dung used in the field, pulverises only a small part of the staple ; but how long a time may be required for our instruments to pulverise an equal part, it depending much upon the weather and the degree of friability of the soil, is uncertain.

I have seen surprising effects from ground, after being kept unexhausted, by ploughing with common ploughs for two whole years running ; and, I am confident, that the expense of this extraordinary tillage and fallow will not, in many places, amount to above half the expense of a dressing with dung ; and if the land be all the time kept in our sort of little ridges of the size most proper for that purpose, the expense of ploughing will be diminished one-half, besides the advantage the earth of such ridges hath of being friable in weather which is too moist for ploughing the same land on the level.

I have made many trials of fine dung on the rows, and notwithstanding the benefit of it, I have, for these several years past, left it off, finding that a little more hoeing will supply it at a much less expense, than that of so small a quantity of manure, and of the hands necessary to lay it on, and of the carriage.

CHAPTER VI.

OF TILLAGE.

TILLAGE is breaking and dividing the ground by spade, plough, hoe, or other instruments, which divide by a sort of attrition (or contusion), as dung does by fermentation*.

By dung we are limited to the quantity of it we can procure, which in most places is too scanty.

But by tillage we can enlarge our field of subterranean pasture without limitation, though the external surface of it be confined within narrow bounds.

Tillage may extend the earth's internal superficies, in proportion to the division of its parts, and as division is infinite, so may that superficies be.

Every time the earth is broken by any sort of tillage or division there must arise some new superficies of the broken parts which never has been open before: for when the parts of earth are once united and incorporated together, it is morally impossible that they, or any of them, should be broken again, only in the same places; for to do that, such parts must have again the same numerical figures and dimensions they had before such breaking, which even by an infinite division could never be likely to happen. As the letters of a distich, cut out and mixed, if they should be thrown up

* "*Neque enim aliud est colere quam resolvere, et fermentare terram.*"—Columella.

And since the artificial pasture of plants is made and increased by pulverisation, it is no matter whether it be by the ferment of dung, the attrition of the plough, the contusion of the roller, or by any other instrument or means whatsoever, except by fire, which carries away all the cement of that which is burned.

never so often, would never be likely to fall into the same order and position with one another, so as to recompose the same distich.

Although the internal superficies may have been drained by a preceding crop, and the next ploughing may move many of the before divided parts without new breaking them, yet such as are new broken, have, at such places where they are so broken, a new superficies, which never was or did exist before ; because we cannot reasonably suppose that any of those parts can have in all places (if in any places), the same figures and dimensions twice.

For as the matter is divisible, *ad infinitum*, the places or lines whereat it is so divisible must be, in relation to number, infinite, that is to say, without number ; and must have at every division superficies of parts of infinite variety* in figure and dimensions.

And because it is morally impossible the same figure and dimensions should happen twice to any one part, we need not wonder how the earth, every time of tilling, should afford a new internal superficies (or artificial pasture), and that the tilled soil has in it an inexhaustible fund, which by a sufficient division (being capable of an infinite one) may be produced.

Tillage (as well as dung) is beneficial to all sorts of land †.

* Their variety is such, that it is next to impossible any two pieces or clods in a thousand acres of tilled ground should have the same figure and equal dimensions ; or that any piece should exactly tally with any other, except with that from whence it was broken off.

† It is of late fully proved, by the experience of many farmers, that two or three additional ploughings will supply the place of dung, even in the old husbandry, if they be performed at proper seasons ; and the hiring price of three ploughings, after land has been thrice ploughed before, is but twelve shillings, whereas a dunging will cost three pounds. This was accidentally discovered in my neighbourhood, by the practice of a poor farmer, who, when he had prepared his land for barley, and could not procure seed to sow it, ploughed it on till wheat-seed time, and (by

Light land being naturally hollow, has larger pores, which are the cause of its lightness. This, when it is by any means sufficiently divided, the parts being brought nearer together, becomes for a time, bulk for bulk, heavier; *i. e.*, the same quantity will be contained in less room, and so is made to partake of the nature and benefits of strong land, viz., to keep out too much heat and cold, and the like.

But strong land being naturally less porous, is made for a time lighter (as well as richer) by a good division; the separation of its parts makes it more porous, and causes it to take up more room than it does in its natural state, and then it partakes of all the benefits of lighter land.

When strong land is ploughed, and not sufficiently, so that the parts remain gross, it is said to be rough, and it has not the benefit of tillage: because most of the artificial powers (or interstices) are too large, and then it partakes of the inconveniences of the hollow land untilled.

For when the light land is ploughed but once, that is not sufficient to diminish its natural hollowness (or pores), and, for want of more tillage, the parts into which it is divided, by that once (or perhaps twice) ploughing, remain too large, and consequently the artificial pores are large also and in that respect are like the ill-tilled strong land.

means of such additional ploughing) without dung, had so good a crop of wheat, that it was judged to be worth more than the inheritance of the land it grew on.

The same effects follow when they prepare land for turnips, since they are come in fashion, and sow them several times upon several ploughings, the fly as often taking them off; they have from such extraordinary tillage a good crop of wheat, instead of the lost turnips, without the help of dung; hence double ploughing is now become frequent in this country.

The reason why land is enriched by lying long unploughed is, that so very few vegetables are carried off it, very little being produced, the exhaustion is less than what is added to the atmosphere, cattle, &c. But when it is ploughed, a vastly greater quantity of vegetables is produced and carried off, more than by the old husbandry is returned to it.

Light land having naturally less internal superficies, seems to require the more tillage* or dung to enrich it; as when the poor, hollow, thin down shave their upper part (which is the best) burned, whereby all (except a *caput mortuum* or *terra damnata*) is carried away, yet the salts of this spread upon that barren part of the staple which is unburned, divide it into so very minute particles, that their pasture will nourish two or three good crops of corn: but then the plough, even with a considerable quantity of dung, is never able afterwards to make a division equal to what those salts have done, and therefore such burned land remains barren.

Artificial pores cannot be too small, because roots may the more easily enter the soil that has them, quite contrary to natural pores; for these may be, and generally are, too small and too hard for the entrance of all weak roots, and for the free entrance of strong roots.

Insufficient tillage leaves strong land with its natural pores

* As for puffy land, which naturally swells up instead of subsiding, though its hollowness is much abated by tillage, yet is thought little better than barren land, and unprofitable for corn. But what we usually call light land, is only comparatively so, in respect of that which is heavier and stronger. And this sort of light land becomes much lighter by being ill tilled; the unbroken pieces of turf underneath, undissolved, forming large cavities, increase its hollowness, and consequently its lightness. I have often known this sort of land despised by its owners, who feared to give it due tillage, which they thought would make it so light that the wind would blow it away; but whenever such has been thoroughly tilled, it never failed to become much stronger than before; and considering that it is tilled with less expense than very strong land, it is, for several sorts of corn, found to be more profitable than land of greater strength and richness, that is more difficult to be tilled.

And I am apt to think that this sort of light land acquires more cement by having its external superficies often changed and exposed to the dews and other benefits of the atmosphere, as well as by the increase of its internal superficies, which is, the surface of all the divided parts of earth or the pasture of plants; the one being augmented by the other; *i. e.*, that into the more parts the earth is broken, the more cement will it obtain from the sulphur which is brought by the dews.

too small, and its artificial ones too large. It leaves light land with its natural and artificial pores both too large.

Pores that are too small in hard ground, will not easily permit roots to enter them.

Pores that are too large in any sort of land, can be of little other use to roots, but only to give them passage to other cavities more proper for them, and if in any place they lie open to the air, they are dried up and spoiled before they reach them.

For fibrous roots (which alone maintain the plant, the other roots serving only for receiving the chyle from them, and conveying it to the stem) can take in no nourishment from any cavity, unless they come into contact with, and press against all the superficies of that cavity which includes them; for it dispenses the food to their lacteals by such pressure only. But a fibrous root is not so pressed by the superficies of a cavity whose diameter is greater than that of the root.

The surfaces of great clods form declivities on every side of them, and large cavities, which are as sinks to convey what rain and dew bring too quickly downwards to below the ploughed part.

The first and second ploughings, with common ploughs, scarcely deserve the name of tillage; they rather serve to prepare the land for tillage.

The third, fourth, and every subsequent ploughing, may be of more benefit and less expense than any of the preceding ones.

But the last ploughings will be more advantageously performed by way of hoeing, as in the following chapters will appear.

For the finer land is made by tillage, the richer will it become, and the more plants it will maintain.

It has been often observed that when part of a ground has

been better tilled than the rest, and the whole ground constantly managed alike, afterwards for six or seven years successively, this part that was but once better tilled, always produced a better crop than the rest, and the difference, remained very visible every harvest.

One part being once made finer, the dews did more enrich it; for they penetrate within, and beyond the superficies, whereto the roots are able to enter. The fine parts of the earth are impregnated throughout their whole substance with some of the riches carried in by the dews, and there repositied; until by new tillage, the insides of those fine parts become superficies; and as the corn drains them they are again supplied as before: but the rough large parts cannot have that benefit, the dews not penetrating to their centres, they remain poorer. *Minus habentibus minus datur, et vice versa.*

I think nothing can be said more strongly to confirm the truth of this, than what is related by the authors quoted by Mr. Evelyn*. To this effect, viz.,

“Take of the most barren earth you can find, pulverise it well, and expose it abroad for a year, incessantly agitated, (that is, *stirred* often), it will become so fertile as to receive an exotic plant from the furthest Indies, and to cause all vegetables to prosper in the most exalted degree, and to bear their fruit as kindly with us, as in their natural climates.”

This artificial dust†, he says, will entertain plants which

* In page 17, 18, and 19, of his Phil. Discourse of Earth.

† Though it may be impossible for the plough to reduce the whole staple into so fine powder, yet, the more internal superficies it makes, the more dust will be made by the atmosphere in proportion; and great clods perhaps are of no use to plants, but by that dust they let fall, being thence extricated by the insensible ferment of the nitrous air; and the surfaces of this artificial dust must receive such operations from the air, before the utmost fertility be obtained.

refuse dung and other violent applications, and that it has a more nutritive power than any artificial dungs or compost whatsoever : and further, that by this toil of pulverising “ it “ is found that soil may be so strangely altered from its “ former nature, as to render the harsh and most uncivil “ clay * obsequious to the husbandman, and to bring forth “ roots and plants, which otherwise require the lightest and “ hollowest mould †.”

It is to be supposed that the Indian plants had their due degrees of heat and moisture given them, and I should not choose to bestow this toil upon the poorest of earth, in a field or garden, though that be the most sure wherein to make the experiment.

This is the most proper trial of the effect of pulverisation by pounding and grinding ; but land may be so barren, that plough or spade may not be sufficient to pulverise it to that degree which is necessary to give it the same fertility, that pounding in a mortar, or grinding betwixt marbles (as colours are ground), can.

I never myself tried this way of pounding or grinding, because impracticable in the fields.

But I have had the experience of a multitude of instances, which confirm it so far, that I am in no doubt that any soil ‡ (be it rich or poor) can ever be made too fine for tillage.

* But I take harsh uncivil clay to be the least profitable of any to keep in tillage.

† To this dust, *Namque hoc imitatur arando* ought to be applied, and not to *putre solum*, which itself needs tillage as well as strong land ; but it seems the ancients did not observe the difference between natural pores (or hollowness) and artificial ones, though it is very great, as is shown in chap. of Pasture of Plants ; it is easier indeed to imitate this artificial dust in hollow than in strong land.

‡ Land that is too hollow and light having no cement to join its parts together, though in nature they are capable of infinite division, yet in practice the plough cannot divide them to any purpose, unless they were first joined, but glides through without breaking them ; being more like

According to some, this rule is only general, and not universal; for, say they, there is a sort of binding gravel, that when it is made fine, will, by a sudden dash of rain, run together like metal; and I have seen the same accident in a particular sort of *white* land, but this very rarely happens to the latter, I never knew it above once, and that was after barley was sown on it; the hardness was only like a very thin ice upon the surface, which was some hindrance to the coming up of the barley, until the harrows going over it once or twice broke that ice or crust, and then it came up very well.

I never had any other sort of land liable to this misfortune; therefore can say nothing to the gravel in that case, nor how deep the constipation may reach in it, nor what remedy is most proper to prevent the ill consequence of it; but if there should be two or three exceptions out of one thousand seventy-nine millions one thousand and sixty different sorts of earth (see Mr. Evelyn's *Terra*, p. 2), it will be no great matter.

But I think these are no real exceptions against any degree of pulverising; for they only show, that some sorts of land, though very few, are subject by accident to lose too soon their pulverisation: and if the fineness were no benefit to that land, such loss of it would be no injury to it.

For it is without dispute, that one cubical foot of this minute powder, may have more internal superficies than a thousand cubical feet of the same, or any other earth tilled in the common manner; and I believe no two arable earths in the world do exceed one another in their natural richness twenty

to the primary particles of water against the plough, which are broken by no force, than to earth; it may be moved but not broken by tillage, and therefore ought not to be reputed arable; nor does it indeed deserve the name of land, but as the desert sands of Libya, to distinguish it from sea.

times ; that is, one cubical foot of the richest, is not able to produce an equal quantity of vegetables, *cæteris paribus*, to twenty cubical feet of the poorest ; therefore, it is not strange that the poorest, when by pulverising it has obtained one hundred times the internal superficies of the rich untilled land, should exceed it in fertility. Or, if a foot of the poorest were made to have twenty times the superficies of a foot of such rich land, the poorest might produce an equal quantity of vegetables with the rich*. Besides there is another extraordinary advantage when a soil has a large internal superficies in a very little compass ; for then the roots of plants in it are better supplied with nourishment, being nearer to them on all sides within reach, than it can be when the soil is less fine, as in common tillage ; and the roots in the one must extend much further than in the other, to reach an equal quantity of nourishment : they must range and fill perhaps above twenty times more space to collect the same quantity of food.

But then the *poor* must have this proportion of excess of internal superficies continued to it, during the whole time of their growth, which cannot be done without frequently-repeated divisions of the soil by hoeing or manure ; else it might require forty times the internal superficies, at the time of sowing, to keep twenty times the internal superficies of the rich till harvest : for although the rich is continually losing some of its artificial pasture, as well as the poor, yet, by losing this equally, they still draw nearer and nearer to the first inequality of their natural pasture.

But poor land, being lighter, has this advantage, that it

* And very poor land well pulverised, will produce better corn than very rich will do, without manure or tillage. The experiment may be made by paring off the turf, and setting corn in the whole ground that is very rich ; and that will show how much the natural pasture of the rich is inferior to the artificial pasture of the poor land.

being more friable than the strong, requires less labour to pulverise it, and therefore the expense of it is much less than in proportion to the excess of poorness of its internal superficies.

But in this fine soil the most weak and tender roots have free passage to the utmost of their extent, and have also an easy, due, and equal pressure everywhere, as in water.

Hard ground makes a too great resistance, as air makes a too little resistance, to the superficies of roots.

Farmers, just when they have brought their land into a condition fit to be further tilled to much greater advantage, leave off, supposing the soil to be fine enough, when with the help of harrows they can cover the seed; and afterwards with a roller they break the clods, to the end that if a crop succeed, they may be able to mow it without being hindered by those clods. By what I could ever find, this instrument, called a roller, is seldom beneficial to good husbands: it rather untills the land, and anticipates the subsiding of the ground, which in strong land happens too soon of itself*.

But more to blame are they, who neglect to give their land due ploughing, trusting to the harrow to make it fine; and when they have thrown in their seed, go over it twenty times with the harrows†, until the horses have trodden it al-

* This injury the roller does, is only when it is used to press down the earth after the seed is sown, and is the greater if land be moist; but the rolling of it in dry weather, when it is to be immediately ploughed up again, is the most speedy way to pulverise the soil, and the harrow is then very useful in pulling up the clods, to the end that the roller may the better come at them to crush them.

† *Nam veteres Romani dixerunt male subactum Agrum qui satis frugibus Oceandus sit.*

Sed ut compluribus iterationibus sic resolvatur Vervactum in pulverem, ut nullum vel exiguum desideret occasionem cum seminaverimus.—Col. lib. 2. cap. 4.

most as hard as a highway, which in moist weather spoils the crop; but on the contrary, the very horses, when the earth is moist, ought all to tread in the furrows only, as in ploughing with a hoe-plough they always do, when they use it instead of a common plough.

CHAPTER VII.

OF HOEING.

HOEING is the breaking or dividing the soil by tillage, whilst the corn or other plants are growing thereon.

It differs from common tillage (which is always performed before the corn or plants are sown or planted) in the times of performing it; it is much more beneficial, and it is performed by different instruments.

Land that is, before sowing, tilled never so much (though the more it is tilled the more it will produce) will have some weeds, and they will come in along with the crop for a share of the benefit of the tillage, greater or less, according to their number, and what species they are of.

But what is most to be regarded is, that as soon as the ploughman has done his work of ploughing and harrowing, the soil begins to undo it, inclining towards, and endeavouring to regain its natural specific gravity; the broken parts by little and little coalesce, unite, and lose some of their surfaces, many of the pores or interstices close up during the seed's incubation and hatching in the ground; and, as the plants grow up, they require an increase of food, proportionable to their increasing bulk; but on the contrary, instead thereof, that internal superficies, which is their artificial pasture, gradually decreases.

The earth is so unjust to plants, her own offspring, as to shut up her stores in proportion to their wants; that is, to give them less nourishment when they have need of more; therefore man, for whose use they are chiefly designed, ought to bring in his reasonable aid for their relief, and force open

her magazines with the hoe, which will thence procure them, at all times, provisions in abundance, and also free them from intruders ; I mean, their spurious kindred, the weeds, that robbed them of their too scanty allowance.

There is no doubt, but that one-third part of the nourishment raised by dung and tillage, given to plants or corn at many proper seasons, and apportioned to the different times of their exigencies, will be of more benefit to a crop, than the whole applied as it commonly is, only at the time of sowing. This old method is almost as unreasonable as if treble the full stock of leaves, necessary to maintain silk-worms until they have finished their spinning, should be given them before they are hatched, and no more afterwards.

Nature, by what she does in the animal economy, seems to point out to us something like hoeing ; for when teeth as ploughs have tilled that soil, or mass (which is earth altered), and when the saliva and ferment of the stomach have served for stercoration to it, then, as a thing of greatest benefit, the bile and pancreas are employed to further, divide, and open, and as it were to hoe it, at the very time when it is ready to be exhausted by the greatest numbers of lacteal mouths situate in the intestines.

A plant is almost as imperfectly nourished by tillage without hoeing, as an animal body would be without gall and pancreatic juice: for roots pass along the soil, as the soil or mass passes along the guts.

Next to hoeing, and something like it, is transplanting, but much inferior ; both because it requires a so much greater number of hands, that by no contrivance can it ever become general, nor does it succeed if often repeated ; but hoeing will maintain any plant in the greatest vigour it is capable of, even unto the utmost period of its age. Besides there is danger in removing a whole plant, and loss of time before the plant can take root again, all the former roots being

broken off at the ends in taking up (for it is impossible to do it without), and so must wait until, by the strength and virtue of its own sap (which by a continual perspiration is daily enfeebled) new roots are formed, which, unless the earth continue moist, are so long in forming, that they not only find a more difficult reception into the closing pores, but many times the plant languishes and dies of an atrophy, being starved in the midst of plenty; but whilst this is thus decaying, the hoed plant obtains a more flourishing state than ever, without removing from the same soil that produced it.

But when the earth does continue moist, many transplanted vegetables thrive better than the species planted in seeds, because the former, striking root sooner, have a greater advantage of the fresh pulverised mould, which loses some of its artificial pasture before the seeds have roots to reach it. The same advantage also have seeds by soaking until ready to sprout before they are planted.

To both these the moisture of the earth is necessary.

It is observed that some plants are the worse for transplanting*. *Fennochio* removed, is never so good and tender as that which is not; it receives such a check in transplanting in its infancy, which, like the rickets, leaves knots that indurate the parts of the fennel, and spoil it from being a dainty.

Hoeing, has most of the benefits without any inconveniences of transplanting; because it removes the roots by little

* As most long tap-rooted plants are; for I have often tried the transplanting of plants of *St.-Foin* and *Lucerne*, and could never find that any ever came near to the perfection that those will do which are not removed, being equally single.

Tap-rooted grasses and turnips are always injured by transplanting; their long root once broken off never arrives at the depth it would have arrived unbroken; as for this reason they cut off the tap-root of an apple-tree, to prevent its running downward, by which it would have too much moisture.

and little, and at different times ; some of the roots remaining undisturbed, always supply the moved roots with moisture, and the whole plant with nourishment sufficient to keep it from fainting, until the moved roots can enjoy the benefit of their new pasture, which is very soon.

Another extraordinary benefit of the new hoeing † in husbandry is, that it keeps plants moist in dry weather, and this upon a double account.

First, As they are better nourished by hoeing, they require less moisture, as appears by Dr. Woodward's experiment that those plants which receive the greatest increase, having most terrestrial nourishment, carry off the least water in proportion to their augment ; so barley or oats, being sown on a part of a ground very well divided by dung and tillage, will come up and grow vigorously without rain, when the same grains, sown at the same time, on the other part, not thus enriched, will scarce come up, or if they do, will not thrive until rain comes.

Secondly, The hoe, I mean the horse-hoe (the other goes not deep enough), procures moisture to the roots from the dews, which fall most in dry weather, and those dews (by what Mr. Thomas Henshaw has observed), seem to be the richest present the atmosphere gives to the earth ; " Having, when putrefied in a vessel, a black sediment like mud at the bottom." This seems to cause the darkish colour to the upper part of the ground. And the sulphur, which is found in the sediment of the dew, may be the chief ingredient of the cement of the earth ; sulphur being very glutinous, as nitre is dissolvent ; dew has both these.

† Hoeing may be divided into deep (which is our horse-hoeing) and shallow, which is the English hand-hoeing ; and also the shallow horse-hoeing, used in some places betwixt rows, where the intervals are very narrow, as sixteen or eighteen inches ; this is but an imitation of the hand-hoe, or a *succedaneum* to it, and can neither supply the use of dung, nor of fallow, and may be properly called scratch-hoeing.

These enter in proportion to the fineness and freshness of the soil, and to the quantity that is so made fine and fresh by the hoe. How this comes to pass, and the reason of it, is shown in the Chapter of Tillage.

To demonstrate that dews moisten the land when fine, dig a hole in the hard dry ground, in the driest weather, as deep as the plough ought to reach; beat the earth very fine, and fill the hole therewith; and, after a few nights' dews, you will find this fine earth become moist at the bottom, and the hard ground all round will continue dry.

Till a field in lands, make one land very fine by frequent deep ploughings, and let another be rough, by insufficient tillage alternately; then plough the whole field crossways in the driest weather, which has continued long, and you will perceive, by the colour of the earth, that every fine land will be turned up moist, but every rough land will be dry as powder, from top to bottom*.

Although hard ground when thoroughly soaked with rain, will continue wet longer than fine tilled land adjoining to it, yet this water serves rather to chill than nourish the plants standing therein, and to keep out the other benefits of the atmosphere, leaving the ground still harder when it is thence exhaled; and being at last once become dry, it can admit no more moisture, unless from a long-continued deluge of rain, which seldom falls till winter, which is not the season for vegetation.

As fine-hoed ground is not so long soaked by rain, so the dews never suffer it to become perfectly dry; this appears by the plants, which flourish and grow fat in this, whilst those

* These experiments will show, how it is in our own power to make *solstitia* become in some measure *humida*, instead of wishing them so; and also proves the Virgilian theory in this verse, viz., *Hic sterilem exiguus ne deserat humor arenam*, to be (as almost all the first Georgic is) directly contrary to truth.

in the hard ground are starved, except such of them which stand near enough to the hoed* earth for the roots to borrow moisture and nourishment from it.

And I have been informed by some persons, that they have often made the like observations; that, in the driest of weather, good hoeing† procures moisture to roots, though the ignorant and incurious fancy it lets in the drought, and therefore are afraid to hoe their plants at such times, when, unless they water them, they are spoiled for want of it.

When land is become hard by lying too long unhoed, the plough in turning a deep furrow from each side of a single

* As when wheat is drilled late in very poor land, so that in the spring the young plants look all very yellow, let your hoe-plough, making a crooked line, like an indenture, on one side of a straight row of this poor wheat in the spring, turn a furrow from it, and in a short time you will see all those yellow plants, that are contiguous to this furrow, change their yellow colour to a deep green; whilst those plants of the same row, which stand farthest off from this indented furrow, change not their colour till afterwards; and all the plants change or retain their colour sooner or later gradually, as they stand nearer to, or farther from it; and the other rows, which have no furrow near them, continue their yellow after all this row is become green and flourishing. But this experiment is best to be made in poor sandy ground, when the mould is friable, else perhaps the different colour may not appear until the furrow be turned back to the row, having lain some time to be somewhat pulverised (or impregnated) by the weather, &c.

This experiment I often made on wheat drilled on the level, before I drilled any on ridges.

The ploughing on furrow in sandy or mellow ground, makes a pulverisation, which is enjoyed *first* by those plants that are the nearest to it; and also delivers them from the weeds, which, though they may be very few, yet there is a vast difference between their robbing the wheat of its pasture in the row, and the wheat's enjoying both that and the whole pasture of the furrow also.

I never remember to have seen a plant poor that was contiguous to a well-hoed interval, unless overpowered by a too great multitude of other plants; and the same exception must be made, if it were a plant that required more or less heat or moisture than the soil or climate afforded.

† But to hoe with advantage against dry weather, the ground must have been well tilled or hoed before, that the hoe may go deep, else the dews, that fall in the night, will be exhaled back in the heat of the day.

row of young plants (suppose of turnips) may crack the earth quite through the row, and expose the roots to the open air and sun in very dry weather ; but if the earth wherein the plants stand be fine, there will be cracks in it. It is therefore the delaying the hoeing too long that occasions the injury.

There is yet one more benefit hoeing gives to plants, which by no art can possibly be given to animals ; for all that can be done in feeding an animal is, what has been here already said of hoeing ; that is, to give it sufficient food, meat, and drink, at the times it has occasion for them ; if you give an animal any more, it is to no manner of purpose, unless you could give it more mouths, which is impossible ; but in hoeing a plant, the additional nourishment thereby given enables it to send out innumerable additional fibres and roots, as in the glass with a mint in it, marked *F*, is seen ; which fully demonstrates, that a plant increaseth its mouths in some proportion to the increase of food given to it ; so that hoeing, by the new pasture it raises, furnishes both food and mouths to plants ; and it is for want of hoeing that so few are brought to their full growth and perfection*.

* A ground was drilled with ray-grass and barley, in rows at five inches distance from each other ; it produced a pretty good crop of ray-grass the second year, as is usual : there was adjoining to it a ground of turnips, that were in rows, with wide intervals horse-hoed ; they stood for seed ; and amongst them there was, in room of a turnip, a single plant of ray-grass, which being hoed as the turnips were, had in every one's opinion that saw it acquired a bulk at least equal to a thousand plants, of the same species in the other ground, though that vast plant had no advantage above the other, except its singleness, and the deep hoeing.

I have seen a chickweed, by the same means, as much increased beyond its common size ; and a plant of mustard-seed, whose collateral branches were much bigger than ever I saw a whole plant of that sort : it was higher than I could reach its top, and indeed more a tree than an herb. Many other sorts of plants have I seen thus increased beyond what I had ever observed before, but none so much as those.

In what manner the sarrition of the ancients was performed in their corn, is not very clear ; this seems to have been their method, viz., when the plants were some time come up, they harrowed the ground, and pulled out the weeds by hand ; the process of this appears in Columella, where he directs the planting of medica to be but a sort of harrowing or raking amongst the young plants, that the weeds might come out the more easily : “ *Ligneis rastris statim jacta semina obruantur. Post stationem ligneis rastris sarriendus et identidem runcandus est ager, ne alterius generis herba invalidam medicam perimat.*”

They harrowed and hoed *rastris* ; so that the *occatio* and *sarritio* were performed with much the same sort of instrument, and differed chiefly in the time ; the first was at seed-time, to cover the seed, or level the ground ; the other was to move the ground after the plants were up.

One sort of their sarrition, was, *Segetes permota terra debere adobruui, ut fructificare possint.* Another sort was thus : *In locis autem frigidis sarriri nec adobruui, sed plana sarritione terram permoveri.*

For the better understanding of these two sorts of sarrition we must consider, that the ancients sowed their corn under furrow ; that is, when they had harrowed the ground, to break the clods and make it level, they sowed the seed, and then ploughed it in ; this left the ground very uneven, and the corn came up (as we see it does here in the same case) mostly in the lowest places betwixt the furrows, which always lay higher ; this appears by Virgil’s *Cum Sulcos æquant Sata* : now when they used *plana sarritio*, they harrowed lengthways of the furrows, which being somewhat hardened, there could be little earth thrown down thence upon the young corn.

But the other sort of sarrition, whereby the corn is said *adobruui*, to be covered, seems to be performed by harrowing

across the furrows, which must needs throw down much earth from the furrows, which necessarily fell upon the corn.

How this did contribute to make corn *fructicare*, is another question. I am in no doubt to say, it was not from covering any part of it (for I see that has a contrary effect), but from moving much ground, which gave a new pasture to the roots ; this appears by the observation of the extraordinary fructification of wheat hoed without being covered, and by the injury it receives by not being uncovered when any earth falls on the rows.

The same author says, *Faba et cætera legumina cum quatuor digitis a terra extiterent recte sarrientur, excepto tamen lupino, cujus semini contraria est sarritio ; quoniam unam radicem habet, quæ sive ferro succisa seu vulnerata est, totus frutex emoritur.*

If they had hoed it only betwixt rows, there had been no danger of killing the lupine, which is a plant most proper for hoeing ; what he says of the lupine having no need of sarrition, because it is able of itself to kill weeds, shows the ancients were ignorant of the chief use of hoeing, viz., to raise new nourishment by dividing the earth, and making a new internal superficies in it.

Sarrition scratched and broke so small a part of the earth's surface, amongst the corn and weed, without distinction, or favouring one any more than the other, that it was a dispute whether the good it did, in facilitating the runcation, or hand-weeding, was greater than the injury it did by bruising and tearing the corn : and many of the ancients chose rather to content themselves with the use of runcation only, and totally to omit all sarrition of their corn.

But hoeing is an action very different from sarrition, and is every way beneficial, no way injurious, to corn, though destructive to weeds ; therefore some modern authors show a profound ignorance, in mistaking, in translating *sarritio* for hoe-

ing; they give an idea very different from the true one: for the ancients truly hoed their vineyards, but not their corn; neither did they plant their corn in rows, without which they could not give it the vineyard-hoeing. Their sarculation was used but amongst small quantities of corn, and is yet in use for flax; for I have seen the sarculum, which is a sort of very narrow hoe, used amongst the plants of flax standing irregularly; but this operation is too tedious and too chargeable to be applied to great quantities of irregular corn.

If they hoed their crops sown at random, one would think they should have made mad work of it; since they were not at the pains to plant in rows, and hoe betwixt them with their bidens, being the instrument with which they tilled many of their vineyards, and enters as deep as the plough, and is much better than the English hoe, which indeed seems, at the first invention of it, to be designed rather to scrape chimneys than to till the ground.

The highest and lowest vineyards are hoed by the plough; first the high vineyards, where the vines grow, almost like ivy, upon great trees, such as elms, maples, cherry-trees, &c.; these are constantly kept in tillage and produce good crops of corn, besides what the trees do yield; and also these great and constant products of the vines are owing to this sort of hoe-tillage; because neither in meadow or pasture grounds can vines be made to prosper; though the lands be much richer, and yet have a less quantity of grass taken off it than the arable has corn carried from that.

The vines of low vineyards, hoed by the plough, have their heads just above the ground, standing all in a most regular order, and are constantly ploughed in the proper season; these have no other assistance but by hoeing, because their heads and roots are so near together, that dung would spoil the taste of the wine they produce, in hot countries.

From these I took my vineyard scheme, observing that

indifferent land produces an annual crop of grapes and wood without dung; and though there is annually carried off from an acre of vineyard as much in substance as is carried off in the crop of an acre of corn produced on land of equal goodness, yet the vineyard-soil is never impoverished unless the hoeing culture be denied it; but a few annual crops of wheat, without dung in the common management, will impoverish and emaciate the soil.

I cannot find either in theory or practice any other good reason for this difference, except that the vineyard-soil is more pulverised by hoeing; and not exhausted by so much more than a competent quantity of plants, as the corn-fields in the common management are: for to speak moderately, these are exhausted by above ten times a competent number; and if their barley-plants were such as the Equivocal Society mention (in advertisement to April), by 17,990 plants more than are absolutely necessary to produce a common crop at a tenfold increase, supposing their relation to that monstrous plant to be true: or if it be true, that one grain of Smyrna wheat produced 9792 grains at one crop, fifteen such monstrous plants on each square perch might produce forty-eight bushels on an acre; for the grains on each plant would weigh twenty ounces troy. And of all sorts of wheat that I have observed, the largest ears have the largest grains (unless blighted), though the ear does not follow the proportion of the straw, but of the nourishment.

I confess, I scarce believe the Society or their authors, in their relation of plants so prolific; and therefore it must be no rule for our number, which may be above twenty times greater, of that or any other species of corn; the plants may be competent to produce more than a common sown crop, and yet not exhaust an indifferent soil more than may be supplied annually from the atmosphere (as the soil of vineyards is), with the help of the same hoeing culture.

But it is no wonder that such a vast unnecessary number of plants, that are seen in sown corn, should exhaust a soil, and make dung or rest necessary to repair that unnecessary exhaustion.

The vine, indeed, has the advantage of being a large perennial plant, and of receiving some part of its nourishment below the staple ; but it has also disadvantages. The soil of the vineyard never can have a true summer fallow, though it has much summer hoeing ; for the vines live in it, and all over it, all the year : neither can that soil have benefit from dung, because though by increasing the pulverisation it increases the crop, yet it spoils the taste of the wine ; the exhaustion of that soil is thereofre supplied by no artificial help but hoeing ; and by all the experience I have had of it, the same cause will have the same effect upon a soil for the production of corn, and other vegetables, as well as upon the vineyard.

All vineyards must be hoed one way or other*, or else they will produce nothing of value ; but corn-fields, without hoeing, do produce something, though nothing in comparison to what they would do with it.

Mr. Evelyn says, that when the soil wherein fruit-trees are planted is constantly kept in tillage, they grow up to be an orchard in half the time they would do if the soil were not tilled ; and this keeping an orchard-soil in arable, is horse-hoeing it.

In some places in Berkshire, they have been used, for a long time, to hand-hoe most sorts of corn with very great success ; and I may say this, that I myself never knew or heard that ever any crop of corn was properly so hoed, but what very well answered the expense even of this hand-work ; but be this never so profitable, there are not a number of hands to use it in great quantities, which possibly was one reason the

* Vines, that cannot be hoed by the plough, are hoed by the bidens.

ancients were not able to introduce it into their corn-fields to any purpose, though they should not have been ignorant of the effect of it, from what they saw it do in their vineyards and gardens.

In the next place I shall give some general directions, which by experience I have found necessary to be known, in order to the practice of this hoeing-husbandry.

I. Concerning the Depth to plant at.

II. The Quantity of Seed to plant.

III. And the Distance of Rows.

I. It is necessary to know how deep we may plant our seed without danger of burying it; for so it is said to be, when laid at a depth below what it is able to come up at.

Different sorts of seeds come up at different depths; some at six inches, or more; some at not more than half an inch. The way to know for certain the depth any sort will come up at is, to make gauges in this manner: saw off twelve sticks of about three inches diameter; bore a hole in the end of each stick, and drive into it a taper peg: let the first peg be half an inch long, the next an inch, and so on; every peg to be half an inch longer than the former, till the last peg be six inches long; then in that sort of ground where you intend to plant, make a row of twenty holes with the half-inch gauge; put therein twenty good seeds, cover them up, and then stick the gauge at the end of that row; then do the like with all the other eleven gauges: this will determine the depth at which the most seeds will come up.

In the common way of sowing it is hard to know the proper depth, because some seeds lying deep, and others shallow, it is not easy to discover the depth of those that are buried; but I have found in drilling of black oats, that when the drill-plough was set a little deeper for trial, very few came up; therefore it is proper for the driller to use the gauges for all sorts of seeds; for if he drills them too deep he may lose his

crop, or if too shallow, in dry weather, he may injure it, especially in summer seeds; but for those planted against winter, there is the most damage by planting too deep.

When the depth is known wherein the seed is sure to come up, we may easily discover whether the seed be good or not, by observing how many will fail; for in some sorts of seeds the goodness cannot be known by the eye; and there has been often great loss by bad seed, as well as by burying good seed; both which misfortunes might be prevented by this little trouble; besides, it is not convenient to plant some sorts of seeds at the utmost depth they will come up at, for it may be so deep, as that the wet may rot or chill the first root, as in wheat in moist land.

The nature of the land, the manner how it is laid, either flat or in ridges, and the season of planting, with the experience of the planter, acquired by such trials, must determine the proper depths for different sorts of seeds.

II. The proper quantity of seed to be drilled on an acre, is much less than must be sown in the common way, not because hoeing will not maintain as many plants as the other; for, on the contrary, experience shows it will always, *cæteris paribus*, maintain more; but the difference is upon many other accounts: as that it is impossible to sow it so even by hand as the drill will do; for let the hand spread it never so exactly (which is difficult to do some seeds, especially in windy weather) yet the unevenness of the ground will alter the situation of the seed; the greatest part rebounding into the holes, and lowest places, or else the harrows in covering, draw it down thither; and though these low places may have ten times too much, the high places may have little or none of it: this inequality lessens in effect the quantity of the seed; because fifty seeds in room of one, will not produce so much as one will do, and where they are too thick, they cannot be well nourished, their roots not spreading to near their natural

extent, for want of hoeing to open the earth. Some seed is buried (by which is meant, the laying them so deep that they are never able to come up, as Columella cautions, *Ut absque ulla resurrectionis spe sepeliantur*). Some lies naked above the ground ; which, with more uncovered by the first rain, feeds the birds and vermin.

Farmers know not the depth that is enough to bury their seed, neither do they make much difference in the quantity they sow on a rough, or a fine acre; though the same that is too little for the one, is too much for the other ; it is all mere chance-work, and they put their whole trust in good ground, and much dung, to cover their errors.

The greatest quantity of seed I ever heard of to be usually sown, is in Wiltshire, where I am informed by the owners themselves, that on some sorts of land, they sow eight bushels of barley to an acre ; so that if it produce four quarters to an acre, there is but four grains for one that is sown, and is a very poor increase, though a good crop ; this is on land ploughed once, and then double-dunged, the seed only harrowed into the stale and hard ground, it is like not two bushels of the eight enters it to grow ; and I have heard, that in a dry summer, an acre of this scarce produces four bushels at harvest.

Stale ground, is that which has lain some considerable time after ploughing, before it is sown, contrary to that which is sown immediately after ploughed ; for this last is generally not so hard as the former.

But in drilling, seed lies all at the same just depth, none deeper, nor shallower than the rest ; here is no danger of the accidents of burying, or being uncovered, and therefore no allowance must be made for them ; but allowance must be made for other accidents, where the sort of seed is liable to them ; such as grub, fly, worm, frost, &c.

Next, when a man, unexperienced in this method, has

proved the goodness of his seed, and depth to plant it at, he ought to calculate what number of seeds a bushel, or other measure or weight contains : for one bushel, or one pound of small seed, may contain double the number of seeds, of a bushel, or a pound of large seed of the same species.

This calculation is made by weighing an ounce, and counting the number of seeds therein ; then weighing a bushel of it, and multiplying the number of seeds of the ounce, by the number of ounces of the bushel's weight ; the product will show the number of seeds of a bushel near enough : then by the rule of three, apportion them to the square feet of an acre ; or else it may be done, by dividing the seeds of the bushel by the square feet of an acre ; the quotient will give the number of seeds for every foot : also consider how near you intend to plant the rows, and whether single, double, treble, or quadruple ; for the more rows, the more seed will be required *.

Examine what is the produce of one middle-sized plant of the annual, but the produce of the best and largest of the perennial sort ; because that by hoeing will be brought to its utmost perfection ; proportion the seed of both to the reasonable product, and when it is worth while, adjust the plants to their competent number with the hand-hoe, after they are up ; and plant perennials generally in single rows ; lastly, plant some rows of the annual thicker than others, which will soon give you experience (better than any other rule) to know the exact quantity of seed to drill.

III. The distances of the rows is one of the most material points, wherein we shall find many apparent objections against

* The narrow space (suppose seven inches) betwixt double, treble, or quadruple rows ; the double having one, the treble two, and the quadruple three of them, are called partitions.

The wide space (suppose of near five feet) betwixt any two of these double, treble, or quadruple rows, is called an interval.

the truth ; which, though full experience be the most infallible proof of it, yet the world is by false notions so prejudiced against wide spaces between rows, that, unless these common (and I wish I could say, only vulgar) objections be first answered, perhaps nobody will venture so far out of the old road as is necessary to gain the experience, without it be such as have seen it.

I formerly was at much pains and some charge in improving my drills, for planting the rows at very near distances, and had brought them to such perfection, that one horse would draw a drill with eleven shares, making the rows at three inches and a half distance from one another ; and at the same time sow in them three very different sorts of seeds, which did not mix, and these, too, at different depths ; as the barley rows were seven inches asunder, the barley lay four inches deep ; a little more than three inches above that, in the same channels, was clover ; betwixt every two of these rows was a row of St.-Foin, covered half an inch deep.

I had a good crop of barley the first year ; the next year, two crops of broad clover, where that was sown ; and where hop clover was sown, a mixed crop of that and St.-Foin, and every year afterwards a crop of St.-Foin ; but I am since, by experience, so fully convinced of the folly of these, or any other such mixed crops, and more especially of narrow spaces ; that I have demolished these instruments (in their full perfection) as a vain curiosity, the drift and use of them being contrary to the true principles and practice of horse-hoeing.

Although I am satisfied that every one who shall have seen as much of it as I have will be of my mind in this matter, yet I am aware that what I am going to advance will seem shocking to them, before they have made trials.

I lay it down as a rule (to myself) that every row of

vegetables, to be horse-hoed, ought to have an empty space or interval of thirty inches on one side of it* at least, and of near five feet in all sorts of corn.

In hand-hoeing there is always less seed, fewer plants, and a greater crop, *cæteris paribus*, than in the common sowing; yet there the rows must be much nearer together than in horse-hoeing; because, as the hand moves many times less earth than the horse, the roots would be sent out

* We call it one row, though it be a double, treble, or quadruple row; because when they unite in the spring, they seem to be all single; even the quadruple then is but as one single row.

Observe, that as wide intervals are necessary for perfect horse-hoeing, so the largest vegetables have generally the greatest benefit by them; though small plants may have considerable benefit from much narrower intervals than five feet.

The intervals may be somewhat narrower for constant annual crops of barley than of wheat; because barley does not shut out the hoe-plough so soon, nor require so much room for hoeing, nor so much earth in the intervals, it being a lesser plant, and growing but about a third part of the time on the ground; but he that drills barley, must resolve to reap it, and bind it up in sheaves; for if he mows it, or does not bind it, a great part will be lost among the earth in the intervals; yet I think that six feet ridges for barley in quadruple rows, are more profitable, especially on a thin soil.

Now upon further experience, I choose ridges of five feet and a half; or if the land be rich, five feet ridges for constant annual crops of barley and of oats; but narrower for a single crop, *i. e.*, when the following crop is to be sown on the level.

He must also take care that the barley be not such as Equivocus relates in p. 199, of his Essay for August, "Good barley where the ear has been equal in length to the straw it grew on." For such would be very difficultly reaped; unless the ears were a foot long.

But it is now found that, in a wet harvest, the best way is not to bind up drilled barley or oats; but instead thereof, to make up the grips into little heaps by hands, laying the ears upon one another inwards, and the stubble ends outwards, so that with a fork that hath two fingers and a thumb, it is very easy to pitch such heaps upon the wagons without scattering or wasting any of the corn.

It is also seen that when reapers take care to set their grips with the butt-ends in the bottoms of the intervals, and the ears properly on the stubble, they will so stand up from the ground as to escape much better from sprouting than mowed corn.

in like proportion ; and if the spaces or intervals where the hand-hoe only scratches a little of the upper surface of them should be wide, they would be so hard and stale underneath that the roots of perennial plants would be long in running through them ; and the roots of many annual plants would never be able to do it.

An instance which shows something of the difference between hand-hoeing and deep hoeing is, that a certain poor man is observed to have his cabbages vastly bigger than any body's else, though their ground be richer and better dunged ; his neighbours were amazed at it, until the secret at length came out, and was only this, as other people hoed their cabbages with a hand-hoe, he instead thereof dug his with a spade ; and nothing can more nearly equal * the use of the horse-hoe than the spade does,

And when plants have never so much pabulum near them their fibrous roots cannot reach it all before the earth naturally excludes them from it ; for to reach it all, they must fill all the pores †, which is impossible. So far otherwise it is, that we shall find it probable that they can only reach the least part of it, unless the roots could remove themselves from place to place, to leave such pores as they had exhausted, and apply themselves to such as were unexhausted ; but they not being endowed with parts necessary for local motion (as animals are) the hoe-plough supplies their want of feet ; and both conveys them to their food, and their food to them, as

* The hoe-plough exceeds the spade in this respect, that it removes more of the roots, and cuts off fewer, which is an advantage when we till near to the bodies of plants that are grown large.

† The roots of a mint, set a whole summer in a glass, kept constantly replenished with water, will, in appearance, fill the whole cavity of the glass ; but by compressing the roots, or by observing how much water the glass will hold when the roots are in it, we are convinced that they do not fill a fourth part of its cavity ; though they are not stopped by water, as they are by earth.

well as provides it for them ; for, by transplanting the roots, it gives them change of the pasture, which it increases by the very act of changing them from one situation to another, if the intervals be wide enough for this hoeing operation to be properly performed.

The objections most likely to prepossess people's minds, and prevent their making trials of this husbandry, are these :

First, They will be apt to think, that these wide, naked spaces, not being covered by the plants, will not be sufficient to make a good crop.

For answer, We must consider, that though corn standing irregular and sparsim, may seem to cover the ground better than when it stands regular in rows, this appearance* is a mere *deceptio visus* ; for stalks are never so thick on any part of the ground as where many come out of one plant, or as when they stand in a row ; and a hoed plant of corn will have twenty or thirty stalks†, in the same quantity of ground where an unhoed plant, being equally single, will have only two or three stalks. These tillered hoed stalks, if they were planted sparsim all over the interval, it might seem well covered, and perhaps thicker than the sown crop commonly is ; so that though these hoed rows seem to contain a less crop, they may contain in reality a greater crop than the sown, that seems to exceed it ; and it is only the different placing that makes one seem greater and the other less than it really is ; and this is only when both crops are young.

The next objection is, that the space or interval not being planted, much of the benefit of that ground will be lost ;

* For the eye to make a comparison between a sown crop and such a hoed crop, it ought when it is half-grown to look on the hoed crop across the rows, because in the other it does so, in effect, which way soever it looks ; but whatever appearance the hoed crop of vegetables (of as large a species as wheat) makes when young, it surely, if well managed, appears more beautiful at harvest than a sown crop.

† I have counted fifty large ears on one single hoed plant of barley.

and therefore the crop must be less than if it were planted all over.

I answer, it might be so, if not horse-hoed ; but if well horse-hoed, the roots can run through the intervals ; and having more nourishment, make a greater crop.

The too great number of plants, placed all over the ground in common sowing, have, whilst it is open, an opportunity of wasting, when they are very young, that stock of provision, for want of which, the greatest part of them are afterwards starved ; for their irregular standing prevents their being relieved with fresh supplies from the hoe. Hence it is that the old method exhausting the earth to no purpose, produces a less crop ; and yet leaves less pabulum behind for a succeeding one, contrary to the hoeing-husbandry, wherein plants are managed in all respects by a quite different economy.

In a large ground of wheat it was proved, that the widest hoed intervals brought the greatest crop of all: dung without hoeing, did not equal hoeing without dung. And what was most remarkable, amongst twelve differences of wider and narrower spaces, more and less hoed, dunged and undunged, the hand-sowed was considerably the worst of all ; though all the winter, and beginning of the spring, that made infinitely the most promising appearance ; but at harvest yielded but about one-fifth part of wheat of that which was most hoed ; there was some of the most hoed, which yielded eighteen ounces of clean wheat in a yard in length of a double row, the intervals being thirty inches, and the partition six inches*.

* The same harvest, a yard in length of a double row of barley, having six inches partition, produced eight hundred and eighty ears in a garden ; but the grains happened to be eaten by poultry before they were ripe, so that their produce of grains could not be known. One like yard of a hoed row of wheat in an undunged field, produced four hundred ears of Lamm-wheat.

A third objection like the two former is, that so small a part of the ground, as that whereon the row stands, cannot contain plants or stalks sufficient for a full crop.

This some authors endeavour to support by arguments taken from the perpendicular growth of vegetables, and the room they require to stand on; both which I having answered elsewhere, I need not say much of them here; only I may add, that if plants could be brought to as great perfection, and so to stand as thick all over the land, as they do in the hoed rows, there might be produced at once many of the greatest crops of corn that ever grew.

But since plants thrive, and make their produce in proportion to the nourishment they have within the ground, not to the room they have to stand upon it, one very narrow row may contain more plants than a wide interval can nourish and bring to their full perfection by all the art that can be used; and it is impossible a crop should be lost for want of room to stand above the ground, though it were less than a tenth part of the surface*.

* Mr. Houghton calculates, that a crop of wheat of thirty quarters to an acre, each ear has two inches and a half of surface; by which it is evident, that there would be room for many such prodigious crops to stand on.

And a quick-hedge, standing between two arable grounds, one foot broad at bottom, and eighteen feet in length, will, at fourteen years growth, produce more of the same sort of wood, than eighteen feet square of a coppice will produce in the same time, the soil of both being of equal goodness.

This seems to be the same case with our hoed rows; the coppice, if it were to be cut in the first years, would yield perhaps ten times as much wood as the hedge; but many of the shoots of the coppice constantly die every year, for want of sufficient nourishment, until the coppice is fit to be cut; and then its product is much less than that of the hedge, whose pasture has not been overstocked to such a degree as the coppice-pasture has been; and therefore brings its crop to greater perfection than the coppice-wood, which has eighteen times the surface of ground to stand on; the hedge has the benefit of hoeing, as often as the land on either side of it is tilled; but the coppice, like the sown corn, wants that benefit.

It is no great wonder that astronomers take notice of those parts of plants alone which exist within that element where they are accustomed to make their stellary observations; or treat of them only as they regard their zenith, not inquiring what is done by the roots within the earth's dark recesses, or how much of her dimensions is necessary to employ them in their office.

But I should have thought Mr. Laurence a better philosopher, than to be so much imposed upon by that quibbling fallacy of Mr. Bradley's about the perpendicular growth of plants, as to call it a demonstration. "And as to hills, though they measure near twice as much as the plain ground they stand upon, yet the produce of the one can be no more than the produce of the other." (*See Mr. Laurence's New System*, p. 63.)

It is very likely, that reverend gentleman may have had opportunities (unless he preaches no better than he ploughs) of seeing all his parishioners stand perpendicularly in his church, as in a row; but his tithe might put him in mind, that many acres of space, or surface, more than the church's area, are necessary for their nourishment; without which, hunger would soon bring them from their perpendicular pasture to an horizontal one; and he might perform his last office for them all at once.

And just so it is with plants though these gentlemen, by their arguments about them, seem to think otherwise; else they would not attempt to calculate the quantity of the earth's surface necessary for them, by the manner of their growth; it being nothing to the purpose, whether it be perpendicular or not: but it is true, that perpendicular plants have most benefit by hoeing; because by that posture they admit the hoe to come the oftener amongst them.

In wide intervals there is another advantage of hoeing, I mean horse-hoeing (the other being more like scratching

and scraping than hoeing); there is room for many hoeings*; which must not come very near the bodies of some annual plants, except whilst they are young; but in narrow intervals this cannot be avoided at every hoeing. It is true, that in the last hoeings, even in the middle of a large interval, many of the roots may be broken off by the hoe-plough, at some considerable distance from the bodies; but yet this is no damage, for they send out a greater number of roots than before; as in the Mint marked *F*, in Chap. I., appears.

In wide intervals those roots are broken off only where they are small, for though they are capable of running out to more than the length of the external parts of a plant; yet it is not necessary they should always do so, if they can have sufficient food nearer to the bodies† of the plants.

And these new, young, multiplied roots are fuller of lacteal mouths than the older ones, which makes it no wonder that plants should thrive faster by having some of their roots broken off by the hoe; for as roots do not enter every pore of the earth, but miss great part of the pasture, which is left unexhausted, so when new roots strike out from the broken parts of the old, they meet with that pasture which their predecessors missed, besides that new pasture which the hoe

* But if it should be asked how many, we may take Columella's rule in hoeing the vines, viz. *Numerus autem vertendi soli (bidentibus) definiendus non est, cum quanto crebrior sit, plus prodesse fassionem conveniat. Sed impensarum ratio modum postulat.*—Lib. 4, cap. 5.

Neither is it altogether the number of hoeings that determine the degrees of pulverisation; for, once well done is twice done, and the oftener the better, if the expense be not excessive.

Poor land, be it never so light, should have the most hoeings; because plants, receiving but very little nourishment from the natural pasture of such land, require the more artificial pasture to subsist on.

† All the mould is never so near to the bodies of plants as it is when the row stands on a high six-foot ridge, when the middle of the interval is left bare of earth at the last hoeing; for then all the mould may be but about a foot, or a foot and a half distant from the body of each plant of a treble row.

raises for them; and those roots which the hoe pulls out without breaking and covers again, are turned into a fresh pasture; some broken and some unbroken, all together invigorate the plants.

Besides the plants of sown corn being treble in number to those of the drilled, and of equal strength and bulk, whilst they are very young, must exhaust the earth whilst it is open, thrice as much as the drilled plants do; and before the sown plants grow large, the pores of the earth are shut against them, and against the benefit of the atmosphere; but for the drilled, the hoe gives constant admission to that benefit; and if the hoe procures them (by dividing the earth) four times the pasture of the sown, during their lives, and the roots devour but one half of that, then, though the hoed crop should be double to the sown, yet it might leave twice as much pabulum for a succeeding crop. It is impossible to bring these calculations to mathematical rules, but this is certain in practice, that a sown crop, succeeding a large undunged hoed crop, is much better than a sown crop that succeeds a small dunged sown crop. And I have the experience of poor worn-out heath-ground, that having produced four successive good hoed crops of potatoes (the last still best) is become tolerable good ground.

In a very poor field were planted potatoes, and in the very worst part of it, several lands had them in squares a yard asunder; these were ploughed four ways at different times; some other lands adjoining to them, of the very same ground, were very well dunged and tilled; but the potatoes came irregularly, in some places thicker, and in others thinner; these were not hoed, and yet at first coming up, looked blacker and stronger than those in squares not dunged, neither that year, or ever, that I know of; yet these lands brought a good crop of the largest potatoes, and very few small ones amongst them; but in the dunged lands, for want

of hoeing, the potatoes were not worth the taking up; which proves, that in those plants that are planted so as to leave spaces wide enough for repetitions of hoeing, that instrument can raise more nourishment to them than a good coat of dung with common tillage.

Another thing I have more particularly observed, viz., that the more successive crops are planted in wide intervals and often hoed, the better the ground does maintain them; the last crop is still the best, without dung or changing the sort of plant; and this is so visible, in parts of the same field, where some part having a first, some other part a second, the rest a third crop growing all together at the same time; which seems to prove that as the earth is made by this operation to dispense or distribute her wealth to plants, in proportion to the increase of her inner superficies (which is the pasture of plants), so the atmosphere, by the riches in rain and dews, does annually reimburse her in proportion to the same superficies, with an overplus for interest: but if that superficies be not increased to a competent degree, and by frequent repetitions of hoeing, kept increasing (which never happens in common husbandry) this advantage is lost; and, without often-repeated stercoration, every year's crop grows worse; and it has been made evident by trials, which admit of no dispute, that hoeing, without dung or fallow, can make such plants as stand in wide intervals, more vigorous in the same ground, than both common dunging and fallowing can do without hoeing.

This sort of hoeing has in truth every year the effect of a summer-fallow, though it yearly produce a good crop.

This is one reason of the different effects plants have upon the soil; some are said to enrich it, others to burn it (*i. e.* to impoverish it); but I think it may be observed, that all those plants which are usually hoed, are reckoned among the enrichers; and though it be certain that some species of plants

are, by the heat of their constitution, greater devourers than those of another species of equal bulk; yet there is reason to believe, that were the most cormorant plant of them all to be commonly hoed, it would gain the reputation of an enricher or improver of the soil, except it should be such as might occasion trouble, by filling it full of its shattered seeds, which might do the injury of weeds to the next crop; and, except such plants, which have a vast bulk to be maintained a long time, as turnip-seed*.

But this must be intended of the deep horse-hoeing; for turnips that stand for seed are such devourers, and feed so long on the soil, that though they are hand-hoed, such a shallow operation doth not supply the usual thickness of those plants with pasture sufficient to raise their stems to half their natural bulk; and they leave so little of that pasture behind them, that the soil is observed to be extremely impoverished for a year or two, and sometimes three years after them; but it is otherwise with my horse-hoed turnip-seed; for I never failed of a good crop of barley after it sown on the level in the following spring, though no dung had been used on the land where the turnip-seed grew for many years. And also my barley-crops thus sown after two successive crops of turnip-seed without a fallow between them, are as good as those sown after a single crop of it. For I have several times made these turnip-seed crops annual, that is, to have two crops of it in two years, which would in the old way require three years, because this crop stands about a year on the ground, and is not ripe until midsummer, which is too late to get that land into a tilth proper to plant another seed-crop on it the same summer; neither can the soil be able to bear such another crop immediately after being so much exhausted and unploughed for a

* Turnips run to seed not till the second summer.

whole year, except it be extraordinary rich, or much dunged. However two crops of turnip-seed immediately succeeding one another, is what I never knew or heard of, except my own that were horse-hoed; and of these the second crop was as good as the first; their stalks grew much higher than they usually do in the common way, and though the number of plants was much less, their produce was so valuable, that the Vicar's agent declared, he made twenty shillings per acre of his tithe of a whole field which he tithed in kind. The expense of these crops was adjudged to be answered by the fuel of the threshed stalks. It must be noted, that the extraordinary value of these crops arose, not from a greater quantity of seed than some common crops, but from their quality, experience having brought this seed into great esteem, on account of its being perfectly clean, and produced by large turnips of a good sort, and of a proper shape; for those that are not well cultivated are very apt to degenerate, and then their seed will produce turnips of a small size, and of a long rapy ill shape.

The wider the intervals are the more earth may be divided, for the row takes up the same room with a wide or a narrow interval; and therefore with the wide, the unhoed part bears a less proportion to the hoed part than in the narrow.

And it is to no purpose to hoe where there is not earth to be hoed, or room to hoe it in.

There are many ways of hoeing with the hoe-plough; but there is not room to turn two deep clean furrows in an interval that is narrower than four feet eight inches; for if it want much of this breadth, one at least of these furrows will reach and fall upon the next row, which will be very injurious to the plants, except of grown St.-Foin, and such other plants that can bear to have the earth pulled off them by harrows.

Thus much of hoeing in general may suffice; and different

sorts of plants requiring different management, that may more properly be described in the Chapter where particular vegetables are treated of.

It may not be amiss to add that all sorts of land are not equally proper for hoeing; I take it that a dry friable soil is the best. Untractable wet clays, and such hills that are too steep for cattle to draw a plough up and down them, are the most improper*.

That it is not so beneficial to hoe in common fields, is not in respect of the soil, but to the Virgilian principles, which have bound the owners to unreasonable customs of changing the species of corn, and make it necessary to fallow every second, third, or fourth year at furthest.

* For by hoeing across the hill, the furrow turned against the declivity cannot be thrown up near enough to the row above it; and the furrow that is turned downwards will bury the row below it.

CHAPTER VIII.

OF WEEDS.

PLANTS that come up in any land of a different kind from the sown or planted crop, are weeds.

That there are in nature any such things as *inutiles herbæ* the botanists deny, and justly too, according to their meaning.

But the farmer, who expects to make profit of his land from what he sows or plants in it, finds not only *herbæ inutiles*, but also *noxia*, unprofitable and hurtful weeds; which come like *muscæ*, or uninvited guests, that always hurt and often spoil his crop, by devouring what he has, by his labour in dunging and tilling, provided for its sustenance.

All weeds, as such, are pernicious, but some much more than others; some do more injury, and are more easily destroyed; some do less injury, and are harder to kill; others there are which have both these bad qualities. The hardest to kill are such as will grow and propagate by their seed, and also by every piece of their roots, as couch-grass, coltsfoot, melilot, fern, and such like. Some are hurtful only by robbing legitimate (or sown) plants of their nourishment, as all weeds do; others both lessen a legitimate crop by robbing it, and also spoil that crop which escapes their rapine, when they infect it with their nauseous scent and relish, as melilot, wild-garlic, &c.

Weeds starve the sown plants by robbing them of their provision of food*, not of their room (as some authors vainly imagine), which will appear by the following experiment.

* A tree of any sort will spoil corn all round it, in a large circle; half an acre of turnips has been spoiled by one; hereby it is plain that trees rob as weeds; because it is not by their shadow, there being as much

Let three beds of the same soil, equal and equally prepared, be sown with the same sort of corn. Let the first of these beds be kept clean from weeds: in the second, let a quantity of weeds grow along with the corn; and in the third, stick up a quantity of dead sticks, greater in bulk than the weeds.

It will be found that the produce of the corn in the first will not exceed that of the third bed; but in the second, where the weeds are, the corn will be diminished in proportion to the quantity of weeds amongst it.

The sticks having done no injury to the corn, show there was room enough in the bed for company to lodge, would they forbear to eat; or else (like travellers in Spain) bring their provision with them to their inn, or (which would be the same thing) if weeds could find there some dish so disagreeable to the palate of the corn, and agreeable to their own, that they might feed on it without robbing, and then they would be as innocent as the sticks, which take up the same room with the weeds.

The quantity of nourishment weeds rob the corn of, is not in proportion only to their number and bulk, but to the degrees of heat in their constitution, as appears by the instance of charlock and turnips, mentioned in the chapter "Of Change of Species."

It is needless to go about to compute the value of the damage weeds do, since all experienced husbandmen know it to be very great, and would unanimously agree to extirpate their whole race as entirely as in England they have done the wolves, though much more innocent and less rapacious than weeds*.

damage done by them on the south side, where their shadow never comes, as on their north side; nor can it be by their dropping, for it is the same on the side where a tree has no boughs to drop over the plants, when they are also at a very great distance from all parts of the tree, except its roots.

* If we consider the crops they utterly destroy, and those they extremely diminish, and that very few crops escape without receiving injury from them, it may be a question whether the mischief weeds do to our corn, is not as great as the value of the rent of all the arable lands in England.

But alas ! they find it impossible to be done, or even to be hoped for, by the common husbandry, and the reasons I take to be these:—

The seeds of most sorts of weeds are so hardy, as to lie sound and uncorrupt for many years*, or perhaps ages, in the earth; and are not killed until they begin to grow or sprout, which very few of them do unless the land be ploughed, and then enough of them will ripen amongst the sown crop, to propagate and continue their species, by shedding their offspring in the ground (for it is observed they are generally ripe before the corn), and the seeds of these do the same in the next sown crop; and thus perpetuate their savage, wicked† brood, from generation to generation.

Besides, their seeds never all come up in one year, unless the land be very often ploughed; for they must have their exact depth and degrees of moisture and heat to make them grow; and as such as have not these will lie in the ground and retain their vegetative virtue for ages; and the common usual ploughings not being sufficient to make them all, or the greatest part grow, almost every crop that ripens increases the stock of seed, until it make a considerable part of the staple of such land as is sown without good tillage and fallowing.

The best defence against these enemies which the farmer has hitherto found, is to endeavour their destruction by a good summer fallow: this indeed, if the weather be propitious, does make havoc of them; but still some will escape one year's prosecution..

Either by being sometimes situate so high that the sun's

* The seeds of Lethean poppy (called red-weed) have lain dormant 24 years (the land being during that time in St.-Foin), and then at first ploughing they came up very thick: this I have seen; and so will many other sorts of weeds, when the ground has lain untilld for an age.

† The French call them, *les herbes savages, et les mechantes herbes.*

heat dries them, sometimes lying so deep it cannot reach them: either way, their germination, which would have proved their death, is prevented.

Another faculty secures abundance of them, and that is, their being able to endure the heat and moisture of one year without growing; as wild oats, and innumerable other sorts of weeds will do; for gather these when ripe, sow them in the richest bed, water them, and do all that is possible to make them grow the first year, it will be vain labour; they will resist all enticements until the second; that is, if you gather them in autumn, you cannot force them to grow until the next spring come twelvemonth; and many of them will remain dormant even to the next year after that, and some of them longer.

I have not tried by sowing them (*wild oats*, &c.) in a bed myself, but have been so informed by others: and my own experience hath frequently shown me, that they will come up, after lying many years in the ground; and that very few sorts of weeds will come all up the first year as corn doth: if they die, the tillage of one year's summer fallow might extirpate them.

By this means, one year's summer fallow can have no effect upon them, but to prepare the soil for their more vigorous growth and plentiful increase the next year after, and very rarely will the farmer fallow his land two years successively: and often the dung, which is made of the straw of sown corn, being full of the seeds of weeds, when spread on the fallows encumbers the soil with another stock of weeds, as ample as that the fallowing has destroyed; and though perhaps many of these may not grow the next year, they will be sure to come up afterwards.

The other old remedy is what often proves worse than the disease; that is, what they call weeding among sown corn; for if, by the hook or hand they cut some sorts (as thistles)

while they are young, they will sprout up again, like hydras, with more heads than before; and if they are cut when full-grown, after they have done almost their utmost in robbing the crop, it is like shutting the stable-door after the steed is stolen.

The best way to destroy them is to pull them up, roots and all, out of the rows whilst they are young.

Hand-weeders often do more harm to the corn with their feet, than they do good by cutting or pulling out the weeds with their hands; and yet I have known this operation sometimes cost the farmer twelve shillings an acre; besides the damage done by treading down his wheat; and after all, a sufficient quantity of them have escaped, to make a too plentiful increase in the next crop of corn.

The new hoeing-husbandry in time will probably make such an utter riddance* of all sorts of weeds, except such as come in the air†, that as long as this management is properly continued, there is no danger to be apprehended from them; which is enough to confute the old error of equivocal generation, had it not been already sufficiently exploded, ever

* A very pernicious, large, perennial weed, like burrage, with a blue flower infested a piece of land for time out of mind; hoeing has destroyed it utterly, not one of the species has been seen in the field these seven years, though constantly tilled and hoed.

† The seeds of some weeds may be suspected to come in the air; as the seed of the grass that grew in Cheapside, in the time of the plague; but it might come from seeds in the dirt, brought thither by the feet of people and cattle, and by the wheels of coaches, carts carrying hay or otherwise: continual treading might keep it from growing, and when the treading ceased, it is no wonder the seeds should furnish the streets with grass.

And I have observed on the floors, two story high, of a lone, ruinous, uninhabited house, being long uncovered, a sort of herb growing very thick; I think it was pimpernel, and believe that its seeds did not come thither in the air; but in the sand which was mixed with the mortar that had fallen from the ceilings, and it is like there were few seeds at first, yet, these ripening for several years, shed their seeds annually, until the floors became all over very thick planted: besides, hay-seeds and pimpernel are too heavy to be carried far by the air.

since the demonstration of Mapighiuses experiment. For if weeds were brought forth without their proper seeds, the hoeing could not hinder their production, where the soil was inclined naturally to produce them.

And except also such weeds whose seed is carried by birds, which is the most common manner of transporting the seeds of vegetables from field to field, against the consent of the owner : for birds, whether great or small, do not care to eat their prey where they take it, but generally choose some open place for that purpose. It is, I am persuaded, by this means chiefly, that a vineyard or field made ever so clean from grass, will, in lying untilld a few years, be replenished with a turf of that neighbouring species of grass which best suits the heat and moisture of the soil : yet there are some species of seeds that birds (at least such as frequent the place) do not effect ; else the burrage-weed (mentioned p. 121, *n.*) would have appeared again in my field in some of the many years since the hoeing has extirpated it there ; for it grows plentifully in the unploughed way adjoining thereto.

I never heard that any author has been dissatisfied with this experiment, except Equivocus, who (unless my memory deceives me) has falsely quoted it ; for he leaves out the latter part of it, viz., that when seeds were put into the glass, the earth produced them into plants very soon.

His objections against the fairness of this experiment are two, viz., that the lawn (I think it was) deprived the earth of some part of the powers, that he affirms would produce plants equivocally. And that the time the earth was in the glass was not sufficient for the effect of those powers.

For answer to the first objection : What he calls a fine linen cloth was only to keep out seeds from being conveyed into the glass by the air. The sun's influence was rather increased by the refraction through the glass : air, rain, dew, and all sorts of particles of the atmosphere, might enter

through the lawn cover : and it was plain, that nothing was wanting for production but seeds, which, when they were thrown in, were produced with no other helps than the earth had whilst nothing was produced. And we see plants come up under a north wall from earth whereon the sun doth not shine ; and even in places where there is not so free an air as that earth in the glass enjoyed.

As to the second objection : Equivocus owns the glass stood a long time ; but it seems it was not long enough for the earth in it to produce plants without corporeal seeds. I would have him let the world know, how long a time he requires earth to remain in that manner for determining that point against him.

Equivocus seems to object against that experiment for the fairness of it ; and to show how much he abhors every fair experiment that discovers truth, he quotes most unfair ones against it.

His first I observe, of this sort, is, that when earth taken out of cellars, and exposed on the top of a house, plants such as grow in the neighbourhood will come up in it. What can be hence inferred in proof of equivocal generation, unless we are sure, that no seeds of those plants were in that earth when in the cellars ; and unless the top of the house was so high as to be above the reach of winds and birds that could carry seeds thither ?

The wormwood coming up amongst the rubbish is no fairer an experiment than his other ; for though it came up in the spring, when there are no seeds to shed ; yet the seeds might be carried thither in the autumn or in the winter, for wormwood holds some of its seed even in winter, when some sorts of birds (as goldfinches) being hungry take it out, and sometimes carry it off to eat it, and love to peck it on dry ground ; and the rubbish of a house seems a proper situation for their feeding on it ; and they generally leave some seeds behind

them in such places; and yet Equivocus is so vain as to affirm, that “this is a plain instance, that those plants did not derive their original from real seed.”

As to his instances of mustard-seed, furze, broom, charlock, and innumerable other species of plants which might be found, which Equivocus and some of the most ignorant of the vulgar imagine to be produced from a fortuitous concourse of particles, and not from real corporeal seeds; they are answered by Equivocus himself in his Essay of May, p. 60, as follows: “that there are many seeds which lie long in the ground “without any visible signs of germination is not to be disputed.” And I see no impossibility against their having lain so from the deluge, if not from the creation of the world (I mean such of them as lie deep in the earth, and have never been exposed to the sun, air, &c.); however, there is less impossibility of that, than of their being generated by a fortuitous concourse of atoms or particles.

A seed that by its smallness is invisible to the naked eye, contains in it an almost infinite progeny of its own species, and is a little world, whose creation is as miraculous a work of infinite wisdom as the great world; and one might as well be produced by a fortuitous concourse, &c. as the other.

Nature is regular and geometrical in all her works; hence each seed produces no other species of plant but its own; but blind chance is irregular, and if it were possible for it to produce a plant, it would be of some other species than those produced from seeds; therefore, I think, no reasonable man can suspect any plant to be generated by a fortuitous concourse of particles, unless he is satisfied of its being a new species that never appeared in the world before it; neither would any two equivocally-generated plants be of the same species, not being the offspring of parents proper to each.

Indeed, in this respect of singularity (falsehood, ingratitude, and inhumanity) different from the common species of men,

Equivocus himself seems a stronger argument for equivocal generation than any as he brings : and as he founds his faith of that blind doctrine on the opinion of heathen authors, who held it the same for animals as for plants, and that many of the former were generated from putrefaction and corruption, there seems no fortuitous concourse of particles so likely to have produced Equivocus, as of such an unsavory composition mentioned in his Essay of April, p p.72,73, 74. He says “ ordure, dung, and air, actuating on one another may produce,” &c.—I say, *Sterquilinium Equivocum*.

That mushrooms are generated without seed in the manner pretended, from rotten dung that smells of mushrooms is a very fallacious account, since they are known to bear seed in their gills ; and the Paris gardeners rub old dry mushrooms on the dung, which produces the young ones ; by such rubbing the seed comes out of the gills.

And when Equivocus, in his Essay of August, p. 180, describes the manner of making a mushroom-bed, he directs, that it be set with cakes of dung that smell like mushrooms, and then he says there will afterwards “ come up mushrooms enough “ especially if the earth of the mushroom-bed be watered “ with the water wherein mushrooms, which sprung up everywhere in September, are washed.”

Here Equivocus’s lower class of readers must renounce their senses, as well as their reason, in order to free themselves from all suspicion of mushroom-seeds being in those cakes, or in that water, before they can be able to perceive the cogency of his arguments for the equivocal or fortuitous generation of plants, without real corporeal seeds.

As neither Equivocus, nor any other advocate of this blind doctrine, make any distinction between the generation (or production) of plants that bear a large seed, and those that bear a small seed, I hope it may be sufficient to convince them of their error if it can be demonstrated that plants which bear a

large seed are not produced equivocally : for which purpose, let an experiment be made, which shall not be liable to the objections Equivocus makes (though I think unjustly) against that of Malpighius, in the following manner, viz., let there be a very fine wire sieve, such as is used to sift tobacco, through which let be passed what quantity you please of earth of any sort and from any country ; set it without a cover in the open air, where no birds come, especially great birds ; and this may be in some place where people are always present in the day-time : let it thus stand a whole year, or as much longer as you will, and stir it as often as you think fit ; then if no bean, pea, fir, or other plant, bearing such a large seed appear in it ; or in case small birds are kept from that earth by a net, or otherwise, then if no plant, the smallest of whose seeds are too large to pass the meshes of that sieve, come up, I believe every man of sense will be confirmed in the doctrine of univocal generation of all vegetables.

Note. There is no occasion to make this trial of such plants whereof the real corporeal seeds, or their husks, at their coming up may be discovered by the naked eye, or by help of a microscope, as they may be at the first coming up of most sorts of plants.

Many more arguments might be brought against Equivocus on this point ; but *absurdas opiniones accuratius refellere stultum est*. And I think no opinion can be more absurd than this of Equivocus.

The belief of that blind doctrine might probably be one of the causes, that made the ancients despair of finding so great success in hoeing, as now appears ; or else, if they had had true principles, they might perhaps have invented and improved that husbandry, and the instruments necessary to put it in practice.

CHAPTER IX.

REMARKS ON THE BAD HUSBANDRY, THAT IS SO FINELY EXPRESSED IN VIRGIL'S FIRST GEORGIC.

EQUIVOCUS exclaims against me horribly, for this (*title*); but I hope it is without any reason: he is not content with the word finely; but adds judiciously, as if bad husbandry could be judiciously expressed. I defy him to show any place in my book, where I have said an injurious word against the poetry of Virgil, or where he finds that I have said “that there is not a good line in all Virgil’s works that relates to husbandry; or that they are fit for nothing but to be laid on a hand-barrow, and thrown into the fire.” Which he has had the face to affirm, in his dedication to my Lord Lonsdale. I am sure I never said, or thought, there was one bad line in all Virgil’s works; but the praise due to the prince of poets, is, I think, in respect of his poetry only.

- - - - - Terræ
Pingue solum primis extemplo a mensibus anni
Fortes invertant tauri: glebasque jacentes
Pulverulenta coquat maturis solibus æstas,

- - - - - Straight let the vig’rous steer
Turn the rich furrow in the new-born year,
And summer’s heat with rip’ning suns pursue
The sluggish glebe, and all the clod subdue.

- - - officiant lætis ne frugibus herbæ;

- - - lest the weeds the smiling blade withstand.

This is good husbandry, which I must maintain against Equivocus, who in his directions to his reading farmers, tells them, in his Preface to September, that it is time enough to break up strong land in Britain, in May or in June, whereas Virgil directs it to be done in January or February. And

what we esteem strong land in Britain, being much stronger than the Italian; and our climate being more subject to rains, our land should not be broke up later than theirs. And our most experienced farmers find it a less expense, and infinitely more profitable, to break up their wheat-land in winter (being the same time that Virgil calls the spring); they say this first ploughing, and a second in summer, costs them less than one first ploughing (or breaking up) in summer, when the weather is dry. By the former method, they never fail of a sufficient pulverisation, and to kill the weeds; but in the latter, it is as uncertain as the weather, which often disappoints them, but the former never does, according to that excellent verse of Hesiod:

Εἰ ἄρι πολέϊν' Ἰέρεος δὲ νεωμένη οὐ σ' ἀπατήσει.

The consequence of this early fallowing, is to require more iterations (or stirrings) than there is time to perform properly, on land broke up in the summer; and this is the chief benefit of early fallowing; and is so found by all who practise it, as many do of late, ploughing five or six, and some seven times, instead of one or two, on light land and sandy land. But Equivocus says, in Advertisement to his second volume, that it is the custom to plough once, some twice, and others three times at the most, in the stiffest land.

All farmers of my acquaintance that are eminent for being good husbandmen, and have practised from their youth to old age, declare they are very certain, they have many times been at a great loss by ploughing their land too seldom; but never lost by ploughing any sort of land too often. This is from long experience; and I take it, is what Virgil means in strong land; and is undoubtedly good husbandry, which nobody contradicts, except Equivocus, as above.

It is the bad theory of the good husbandry in strong land, that occasions his bad husbandry in light land; for if the effect of pulverisation were generally known (as it may be

demonstrated) to procure and enlarge the pasture of plants, instead of only killing weeds, which is only accidentally done by pulverisation, it having its chief effect, even where no weeds are; I say, if this were known, it could not be denied, that pulverisation is at least as necessary (and in a greater degree) to poor light land, as it is to strong and rich. And it is the custom in the South of France to plough up their light land in the winter, pulverising it by frequent iterations in the summer; and this is done in Languedoc on land so light, that I have seen it ploughed (for wheat) by a plough drawn by a single ass.

This is Virgil's reason for ploughing rich land betimes, and shows the old theory, which never gave any other reason for tillage and hoeing except killing of weeds.

The Equivocal Society having ransacked their old heathen authors to find other reasons, pretend pulverisation to be one; it is indeed an effect of good tillage; but is no more a reason for it, than changing the under and upper sides of the furrow is the reason for turning it; and the Society say pulverisation is poison to light land. What they say of the advantages of summer fallowing being another reason for tillage, is no better, since such fallowing is only good tillage, not a reason for tillage. I do not perceive that they offer any other reasons; if they had any they would have produced them in contradiction to what I have said in my Essay.

At si non fuerit Tellus fœcunda, sub ipsum
Arcturum tenui SAT ERIT suspendere sulco.

But if not fat the soil, it will suffice,
When bright Arcturus mounts the purple skies,
To skim the surface with a gentle share,
And lift the furrow lightly to the air.

When poor land is ploughed late, there is not time enough to plough it so often as reason requires; because there must be a competent exposure between the ploughings; and the poorer it is, the more ploughings (or something else) will be

necessary to pulverise it ; and also such land generally being on a high situation, must be sown early, or the wheat will be in danger of dying in the winter ; therefore, upon all those accounts, it should be earlier ploughed than strong land, besides for the killing of weeds, which is impossible to be done in any sort of land by such tillage as does not move and turn it often enough to make them all grow, which once ploughing never can.

Equivocus is against pulverising this land, because he thinks it would make it too hollow ; but in truth, the contrary of his opinion is true, because pulverisation makes its natural pores less, and its specific gravity greater ; and this Equivocus might have learnt of Virgil himself, if his malice would have given him leave to inquire ; for Virgil, in his second Georgic, relates an experiment, which fully contradicts this his own precept, for dig a pit or hole in light land, and the same earth which comes out of it will not fill it up again. Therefore it filling less room (by the breaking) is a proof of its specific gravity being increased.

He says, in page 13 of his Advertisement to his second volume, “ If the soil was naturally light and hollow, over
“ much ploughing, or pulverising of it, would be not only
“ needless, but also destructive to it.”

In this Equivocus is right ; because too much ploughing or pulverising is impossible ; unless where it is feared the soil should become too rich for the sort of vegetable therein to be sown.

It is insufficient tillage only that makes light land become more hollow and light, upon two accounts : first, as it does not sufficiently diminish the size of its natural pores, the largeness of which is the cause of its hollowness and lightness ; for the size of none of these can be diminished, but by breaking their partitions, few of which are broken by insufficient (*i. e.* Virgilian) tillage. Secondly, it becomes lighter on account of the size of its artificial pores, which,

by insufficient tillage, are made large in proportion to the degree of insufficiency; but, on the contrary, sufficient tillage makes the artificial pores very small, and diminishes the size of the natural pores, in proportion to the degree of that smallness of the artificial.

Equivocus says, that in the west, “they never plough their wheat-lands in the summer, nor till they are ready to sow them, well knowing that if they were to summer-fallow them, it would cause the ground to produce nothing but charlock, and several other weeds of that kind, which are all of them the indelible criteria of poverty.”

But in truth these weeds are only criteria of the worst sort of Virgilian husbandry; for they grow much stronger and larger in rich land; but this is earlier and oftener ploughed, whereby the charlock seeds, &c. grow and are killed, without stocking the ground with their species as they do in poor land that is ploughed late, and but once or twice, where all or most weeds that grow are sure to live and propagate.

I remember to have formerly seen my chalky clivi look all over yellow with blossomed charlock, to which they were very subject when in the hands of a Virgilian tenant, but since they have been a few years used in my hoeing tillage, very little charlock appears in them: nor is there any more charlock on my hill whose second stratum is clay, which about twelve years ago had the thickest and largest crop of it that ever I saw: the seed was ripe, and stood all the winter, and was shed on the land to fill it fuller, yet a few years of my potatoe and turnip management totally extirpated the race of charlock from thence also.

Charlock, therefore, is neither equivocally (which Virgilians term naturally) produced, nor is it an indelible criterion of poverty; for this hill, since it has been made dry, appears by the crops of all sorts it produces to be the richest field I have.

Charlock and other weeds may be a cause of poverty, but never can be an effect of it, in any soil whatever.

Equivocus is wrong to infer that this western husbandry is not Virgilian, because he thinks the farmers there never so much as heard of Virgil's Georgics, when the praised commentator proves it to be so from the Latin words used among husbandmen of that country in their rustic affairs.

Equivocus, in his last-quoted page, and in his two next following it, pretends to bring this opinion of mine concerning pulverisation to the test, by what he most childishly calls an experiment, which is only this, that there is a sort of hollow light land about Wilcot (a place I do not know) in the county of Wilts, part whereof being well limed, produces much better than adjoining lands, of the same sort, not limed. And from hence infers that pulverisation is poison to some soils.

But whether this argument be a test of my opinion, or rather a test of Equivocus's understanding, I leave to the determination of the sober reader; and whether inveterate malice may not so operate on the fibres of a wicked man's brain, as to make him become a *mente captus*.

This test which Equivocus proposes, could prove nothing to the purpose; but if any one will be so curious as to see a test of it, he may go to Fiddleton, and several adjacent parishes not far from Wilcot, and within eight or ten miles of the Devizes in Wiltshire, and he will be convinced (by the present practice there) of the benefit of pulverising light land; he will see thousands of acres that were time out of mind, until within these last twenty years, kept in the once ploughing husbandry, now vastly improved by pulverisation with frequent ploughings; they have there proved by practice what I have demonstrated in theory, viz., that light land requires more ploughing than strong land: they say also, that the summer sun and summer ploughings are of greatest

benefit to light land: they further say, that the longer it is kept in that pulverising way, the more fruitful it grows. These lands were formerly sown (alternately) every other year upon once ploughing, as the rest of the neighbourhood yet are; but now these are sown three years successively on frequent ploughings, and are of double the value to what they were formerly, and to what the other adjoining lands of the same nature unpulverised in the Virgilian method are.

Five years, whereof the three first are sown and the other two unsown, are called a round; and they find that every successive round the land grows better and less light, which proves that the Anti-Virgilian pulverisation in time destroys, or, at least, abates, that pernicious leaven (which was the cause of the hollowness or lightness), and increases the cement of the soil, as the superficies of its parts are frequently increased.

Though the staple of this land may be too thin to acquire the name of strong land, yet it loses so much of its lightness, that it subsides sufficiently after sowing, but not too much.

The substance of this relation I had from a gentleman of honour, learning, and integrity, who was the first who put the pulverising husbandry into practice in that country, upon a large estate of light land.

In Gloucestershire also, which is a western county, I am well informed, that great quantities of very light land, which when kept in the *sat erit* husbandry, were let for half a crown an acre, but being now brought into the pulverising method, are let for ten shillings an acre.

But there is a misfortune in many parishes, that the custom does not permit any one to pulverise his light lands by tillage, until an enclosure be made of them.

Full experiments of this doctrine have been made in Hampshire too, and in other places, which show the bad theory and practice of Virgilians.

And to confute the *sat erit* maxim of Virgil, even the practice of the parish where I live is sufficient. The greatest part of the south side of it is light land, formerly downs, and on the north side, is poor, sandy, light land, formerly a heath: in this they always sowed their wheat on once ploughing, until within these last twenty years. It was about seventeen years ago, that I was walking with a farmer in this part, and saw on one side of a hedge a little field in the occupation of a gentleman, who had fallowed it early, and ploughed it three or four times afterwards, and sowed it with wheat without dung: on the other side of the hedge was a field sown with wheat on once ploughing, according to the old custom, well dunged: it was then near harvest, and the farmer judged the crop of the Anti-Virgilian field at four quarters to an acre, and the other at two bushels, or three at the most; and I afterwards found that he was right in his valuation of those different crops. He said the field which had the poor crop was always accounted the better land of the two, though of the same sort. He said too, that his late father used to observe that this custom of once ploughing did never produce so good crops as the same sort of land did in places where it was the custom to plough often; and the farmer himself could remember fifty years, and never found their once ploughing succeed well. I then asked him the reason why they continued such a bad custom, which was never known to succeed. His answer was, We are still in hopes.

But that custom is now so entirely worn out, that I do not believe there has been an acre of wheat sown upon once ploughing these ten last years in this parish, which is a large one, lying in two counties.

The south side of the parish being very high down-land was reckoned too poor and too light for wheat.

They thought with the Virgilians, that much ploughing

would make it yet lighter ; therefore they used generally to sow it with oats on once ploughing, and to let it lie unsown more years than sown. But now they are convinced of that error, and till the same land as much, or more, than their strong land, of which the middle of the parish that lies in a bottom consists (though it is not my fortune to have any of it). And that light land is, within these last twenty years, so much improved by thorough good summer tillage, that it produces rather better crops of wheat and barley than their rich low land does ; it is not, therefore, become lighter or poorer by pulverisation, but more dense and richer.

The Virgilian error in this matter seems to be their mistaking exhaustion for pulverisation ; for when they sow upon two or three ploughings, which are insufficient for light land (especially whilst full of weeds), the exhaustion may be greater than in proportion to such pulverisation, and then the land must become poorer. This effect, which is owing to exhaustion only, they falsely impute to pulverisation ; for it is demonstrable, both in theory and practice, that no land can become poorer, unless the exhaustion exceeds the pulverisation of it ; nor richer, unless the pulverisation exceeds the exhaustion.

When a well-tilled field is to be sown with corn for three years, leave one land in the middle of it unsown, pulverising it by the plough very often, and suffering no vegetable to grow in it for the first and second years ; but the third year let the whole field be sown alike. Then if this third crop be poorer than the crop of the pulverised land in the middle of it (as it certainly will), it will be evident that the poverty proceeds from the exhaustion, and not from the pulverisation.

It is also demonstrable, that light land requires a greater degree of pulverisation than strong land, when the exhaustion of both is equal.

In answer to the ridicule of Equivocus, in page 15 of the

Advertisement to his second volume, about pulverisation being no catholicon, I say, it may be proved so far a catholicon, that it enlarges and enriches the vegetable pasture, and (if made by the plough) kills weeds, and diminishes the too great specific gravity of strong land ; increases the too little specific gravity of light land. It retains competent moisture, but not too much water. If in proper ridges, it lessens the labour of cattle, by causing the plough to go more easily in strong land.

If Virgil gives no other reason for tillage but the killing of weeds (as I think he does not), and yet in his SAT ERIT directs the ploughing of poor land in such a manner that weeds cannot be killed, but rather propagated and strengthened by it, how can there be a worse theory than Virgil's ? And would it not be wonderful, if the Equivocal Society were what they pretend to be, that they should not give some reason why pulverisation kills weeds in strong land, and breeds them in light land, as they assert it does ? But that assertion is so far from being true, that pulverisation by the plough more easily kills an equal number of the same species of weeds in light land than in strong, because, the former being more friable, the imprisoned seeds are sooner set at liberty to grow in it, in order for their destruction. Some sorts of dung increase weeds, no sort of dung or manure kills them ; yet the Virgilian, in light land, wherein weeds most abound, uses much dung and very little ploughing.

- - Sterilem exiguus ne deserat humor arenam.

Lest moisture—desert the barren sand.

However this reason may hold in other countries, it is certainly wrong in England : for all experience proves, that the more such dry light land is pulverised by early and frequent ploughings, and the deeper the same pulverised mould is, the better the corn that grows on it will endure a dry summer.

By experience, I do not mean the experience of these Virgilians, who know not what pulverisation is, believing that twice or at most thrice ploughing is the utmost that tillage can do, the notion of infinite or indefinite division being to them unintelligible and ridiculous.

I have been informed, by a hill-country farmer, who had learning enough to so far balance the common prejudices of his Virgilian education, that he for many years managed part of his dry, light, down land in the same manner that common good husbands manage their strong land ; viz., he ploughed it three or four times singly dunged with the fold, and one bushel and a half of seed-wheat sown on an acre ; the other part of the same land managed in the old Virgilian method ; viz., ploughed once, more dunged, and four bushels of wheat sowed on an acre ; which greater quantity of dung and seed were much more chargeable than the other. But the different success of these two managements was, that every dry summer the Virgilian produced miserable poor crops, and the other very good ones ; but in wet summers the Virgilian crops were better than the tilled crops, which were too big and lodged. Not to bring in question, whether the lodging might not have been prevented by yet more lightly folding ; it is by this experiment very plain, that the more this dry, light land is pulverised, the more moisture it retains in summer. This farmer is yet living, a man of credit, and can easily make appear the truth of these facts ; and I have myself always observed the same effect of pulverisation in regard to moisture on all sorts of land with which I have been acquainted, at what times soever they were sown or planted.

And this moisture obtained, or rather retained, by pulverisation, whether from dews or rains, is never injurious :—for, as pulverised earth holds a small quantity of water longer than the *sat-erit* tillage does, so it suffers water, when in too great quantity, to descend or exhale sooner from it. The

lodging of the above-mentioned crops on that very dry land must not be imputed to too much water, but rather to too great a number of plants, or other causes.

He directs that poor land should be ploughed late, for fear the moisture should be dried out of it.

This has more need of being enriched by early and frequent ploughings; for all its moisture will be exhaled, and for want of being opened, can receive little return from the atmosphere, the later it is ploughed, the drier it will be.

The *sat erit*, is therefore a great mistake.

But it is only the mistake of Virgilians, and of such vulgar who (as Equivocus, in page 2 of April, says of the lower class of readers) “are not able to distinguish truth from error, or right from wrong.” It is these only are they, who cry, It is enough, when their land is ploughed twice, though it has thereby attained no competent degree of pulverisation, but such as serves only to set some of the weeds a-growing, which being ripe, shed their seed; which being afterwards ploughed in and few of their breed killed, composes a considerable part of the staple of their lands; yet when they come up thick at their once or twice ploughing for their next crop, they fancy the same species are produced equivocally without real corporeal seeds; and then they say, it is ploughing that breeds weeds, which is because they plough often enough to make some of the seeds (of which the soil is very full) grow, but not often enough to kill them when sprouted. If the lands of England were all in such vulgar hands, those three syllables *sat erit* would be, I suppose, a loss of three millions sterling yearly to the public.

It seems absurd to be so solicitous for laying dung upon land to which pulverisation is thought to be poison, when the effect of all sorts of dung is to pulverise more or less in proportion to the quantity of salts therein contained.

That this is an effect of those salts is so evident from the

demonstration of every experiment, that I believe nobody ever did deny it ; but whether they have any other considerable effects upon a soil is uncertain, for the warmth occasioned by their ferment cannot be much, and the addition made to the staple by the substance of the usual quantity of dung of any sort is very little when reduced to earth.

The truth of it is, such poor light land requires a considerable quantity both of dung and of tillage to pulverise it, in proportion to the degree of its poverty. The Virgilians judging otherwise, leave out the tillage, and add more dung than is usual in any other species of husbandry ; the consequence of which practice is, that much the greatest part of this land must lie still at the value of about 2s. per acre, for keeping of a vast number mostly of dry sheep for doubly dunging of the small remainder, which also must not be often sowed, and produces commonly very light crops. But, as I am informed, when farmers of a religion (or rather education) different from those bigoted Virgilians come amongst them, they leave out part of the dung, and add more tillage, sow less seed, and, by a competent use of each, raise better and more crops, making a great improvement on those lands, which, by the Virgilian husbandry, are of little value.

None of the improvements made on any sort of arable land by foreign grasses or turnips could have been introduced into Britain without renouncing the *sat-erit* doctrine of Virgil ; for they will not succeed on any sort of land without pulverisation by tillage ; and they are most generally made on light land, and, therefore, may be properly called Anti-Virgilian, and so may most sorts of hoeing culture for corn, which are always found very beneficial to the husbandman who uses them with discretion.

Clover doth not improve the soil by killing of weeds, as the vulgar imagine ; for, in truth, weeds, especially natural grass, will kill or spoil the clover ; the improvement is there-

ore from other causes, the chief of which is the preparing the land for it by tillage, that kills natural grass, and most other weeds; and those that are left are hindered from propagating by seed, if the clover be mowed before they are ripe, and by the rotting of its large roots, and by such other benefits as are shown that a soil receives from St.-Foin, and other long tap-rooted plants.

The benefit that the clover and turnip husbandry brings to a soil consists in the pulverisation it occasions by tillage as well as by fermentation.

Tenui sulco (a shallow furrow), the land being sterile requires that it be ploughed as deep as the staple will allow; for the poorer it is, the less reason is there to leave any part of it unploughed; and shallow ploughings, though the land be never so fine, lose much of the benefit that dews bring to the ground; because the earth being hard below, will not suffer them to sink so deep, but that they are again exhaled in the day; this keeps it drier and poorer.

Equivocus insinuates to his readers, that I have advised to plough below the staple of such thin land, and bring up the spelt. But every reader will see the contrary is true.

But this ill effect of the shallowness may be helped by doubling the thickness of the staple by raising it into little ridges.

The *mutatis fœtibus*, and *inaratæ gratia terræ* are answered in chap. "Of Tillage," and chap. "Of Change of Species."

Sæpe etiam steriles incendere profuit agros,
Atque levem stipulam crepitantibus urere flammis.

It profits oft to fire the fruitless ground,
And thirsty stubble crackling all around.

It is certain, that Virgil meant the burning the stubble upon rich land, and burning the turf itself of barren land*;

* Such poor land ought, to be oftener ploughed to enrich it, by making it still finer; as the salts which are left after burning and wasting the best

because barren land had no stubble on it to be burnt; but the custom of burning the stubble on the rich plains about Rome continues to this time; and the chief benefit of it is, that by this means they are prevented from being an encumbrance to the next ploughing, and their ashes, together with the dead bodies of serpents, lizards, &c. which the flame kills, become a sort of compost (though a very light one, and next to nothing in quantity), or manure to the soil, which is only warmed, not burnt.

As to the other, viz., the burning the earth itself of the barren fields, especially of those which have a shallow staple, it is a practice so pernicious, and carries away so much of the best part of the surface, that it is not only (as far as I can be informed) wholly left off in Italy, but in most other countries, where the owners of lands have any regard to posterity; for it certainly destroys those thin, poor fields, and after a few crops, renders them scarce worthy the name of an inheritance.

Against burning such land Equivocus agrees with me, but says, that is not the land that Virgil means. To which I answer, that the meaning of Virgil in this point is best known by the followers of his husbandry; and if his late commentator be in the right as to the southern parts of England being the chief seat of it, “where Latin words are in use at “this time among the rustics,” which I believe is true, then there can be no doubt of Virgil’s meaning, or that I have perverted it; for it is, and always hath been, the practice of

part of that poor, thin land, being spread upon the barren remainder, will so divide even that, by fermenting therewith, as to cause it to produce a few crops. But this cannot be so much divided, or pulverised by the plough; unless the ploughings be oftener repeated than any body has ever yet repeated them; and if ever any trial be made to attempt the equalling these ashes, it will be the best to do it by way of hoeing; because a crop is raised by it, at the same time, to help defray the expense of such trial. How frequent hoeing brings moisture, see chap. “Of Hoeing.”

those Virgilians to burn the surface of their poor, thin, hollow downs, and this is the only burning I have treated of. Nor did I hear that any other sort was burnt till of late, and believe burning the other sorts, which Equivocus mentions, is a new practice, and nowhere common.

Equivocus pretends, that Virgil doth not mean the burning of this light sort of soil, because he has just despatched it before by his *sat erit*, &c.; but this pretence is without reason, it being the practice to sow such sometimes without burning, and indeed oftener than with it; and Virgil seems here to treat of burning the same sort of poor land, the ploughing of which he had just before treated of in the *sat erit*; for his words are, *sæpe etiam*, oftentimes also.

He pretends, that Virgil meant those kinds of soils that owe their “sterility to the too close contexture of parts, “which will not suffer the superfluous water to pass off, or “the roots of corn or trees to penetrate or find their way “into, or pass through them, until they are subdued by fire.”

But how burning should prevent the too great plenty of water from causing barrenness by standing too near the surface, I cannot imagine; for barren clays, and that tenacious kind of land, are generally more tenacious below the staple than at the surface, which is, I suppose, the only part to be burnt. And the fire diminishing that, the next surface that remains after the burning will be lower than the former, and thereby retain more water in and upon the remaining staple.

There may be, and I am informed there is, a sort of deep land covered with coarse grass, sedge, and trumpery, which burning might make a quick despatch of, and by reason of its thickness enough may be left for many burnings. But as the upper part is always the richest, some of which the fire carries away, and the rest it converts into a manure, the staple must be diminished, and by many repeti-

tions at last be much impoverished ; as every burning makes it thinner, though it may be a long time before such a soil becomes too thin by frequent burnings.

Equivocus's experiment of burnt earth put into a pot, and set abroad for a year, increasing its weight a sixth part, proves nothing, but that wet earth is heavier than dry earth. It is such another experiment as he gives elsewhere, of old pieces of bricks being thrown out by accident, and in some time increasing in their weight. How knows he their weight was augmented, if they were thrown out by accident without weighing whilst dry ?

Such precarious experiments are convincing to no philosopher but Equivocus.

The reasons Virgil offers for explaining the cause of this short improvement of burning this barren land, are such as, abstracted from the poetry, will appear to be utterly unbecoming the character of a philosopher, who pretends *rerum cognoscere causas*. His are such, that, though contrary to one another, and jarring among themselves, are all of them false, as,

Sive inde occultas vires, et pabula terræ
Pinguia concipiunt.

Whether from thence by Nature's secret laws,
Fresh nourishment the earth, and vigour draws.

The most material answer which Equivocus seems to make to this charge is, in page 17 of his Preface to August, by allowing the incoherence of the three last lines, viz.,

Seu durat magis, et venas astringit hiantes :
Ne tenues pluvix, rapidive potentia solis
Acrior, aut Boreæ penetrabile frigus adurat.

which lines, he says, " this noble poet has in all probability " added by a *licentia poetica*, a license that most of those " poets take, who are to weave their precepts with their " poetry."

Here Equivocus hath indeed for once hit upon the only way of reconciling contradictions; but I may presume to say, with good assurance, that this license is never allowed to a philosopher; and those four reasons of Virgil, I spake of as abstracted from the poetry.

Equivocus (in page 23, of the same Preface) says, that the cement of stiff land (except too much burnt) is not all gone. I have said nothing in my Essay concerning the cement of burnt stiff land; and therefore he equivocates in charging me with fallaciously affirming any thing of it; but by this exception he, I think, doth not deny that the fire carries away the cement in proportion to the degree of burning.

And it is ridiculous to say, that that part of the earth which is not burnt, which I suppose is much the greatest part (only the turf or surface, and not much of the staple passing the fire), is either made opener or looser, braced or relaxed, by the burning of the turf or surface, which is but a small part of the staple, except by what the ashes of the burnt part effect by being spread thereon as a manure.

This is so far from being true, that the fire, instead of giving any sort of strength or nourishment to the earth that is burnt, carries both away, and brings nothing in room thereof. The great decrease of its weight* shows how much is missing.

- - - - - Sive illis omne per ignem
Excoquitur vitium, atque exudat inutilis humor.

Or that the latent vice is purg'd by heat,
And the redundant humours waste in sweat.

There was no vice in it, to be boiled out, except its being

* I am sorry to find that Mr. Evelyn should think, that an intense calcination of the earth increases the very weight of the mould; since even stone burnt to lime loses a third part of its weight by the calcination; and earth, being more sulphureous, loses more of its weight by being burnt, and visibly emits more smoke.

stocked with grass, and wanting tillage. Had there been moisture in it, it would not have burnt, therefore that must have been dried out before the fire could operate.

*Seu plures calor ille vias, et cæca relaxat
Spiramenta, novas veniat qua succus in herbas :*

Or, that the flames unusual tracks explore,
Relax the grit, and open ev'ry pore,
Whence genial moisture hastens through the earth,
Slides to the root, and cheers the tender birth.

I do not well understand what authors mean by the juices of the earth: they seem to mean something beside water, when they add the epithets, sweet and sour.

When earth and water have been altered by the operations they suffer in the vessels of plants, they are converted into juices: but no juice, properly so called, can be made by inorganic matter: therefore it seems a very improper word to express the moisture of the earth, in writing of husbandry, though very elegant in the poet.

It does indeed so relax and open the earth, that all that is fruitful breathes out of it; the fire makes room enough for the juice to reach plants, but the mischief of it is, it leaves no juice at all for them.

*Seu durat magis, et venas astringit hiantes:
Ne tennes pluviæ, rapidive potentia solis
Acrior, aut Boreæ penetrabile frigus adurat.*

Or that the heat the hollow glebe constrains,
Braces each nerve, and knits the gaping veins;
Lest piercing wet, or the swift power of day,
More fierce, or scorching Boreas urge his way.

Hey day! This is both contrary to what he said before of relaxing and opening, and to the fact itself; for fire having reduced the earth (that it leaves) to ashes, which are so hollow, that rain, heat and cold will easily enter them: so loose, that they will not become hard or dense, all their cement being gone.

It is common for the rain to wash them off from the de-

clivity of a hill, and for the wind to blow them away from the plain, they are so light. And it is a demonstration of their sterility, that no manner of vegetable will grow, or live in them. So that the poet had much better have solved this phenomenon by a positive ingenious *Je ne sçai quoui*; or to have left off at this verse, viz.

Effœtos cinerem immundum jactare per agros.

- - - - Nor o'er th' exhausted sand
To spread vile ashes with a friendly hand.

From observing the effect of these impure ashes, he might have discovered the cause he so unfortunately aims at; for it can be no other than, that the cinereal salts being spread upon the unburnt earth that is left, ferment therewith, and reducing it into an almost infinite number of parts, increase proportionably that internal superficies described in the chapter "Of Pasture of Plants;" but if we would compute the loss we sustain in waste and diminution of the staple of our thin land in burning it, we should find these ashes a very dear sort of compost; for, though two or three good crops are received after this manure, whose salts divide more than common ploughing can do, yet the land is become so thin, that whereas it is impossible to injure it so much by crops obtained from fair tillage, but that in a few years it will recover its fertility; yet the mischief done by this fire will never suffer it to equal the same sort of unburnt land, until a general conflagration.

Multùm adeo, rastris glebas qui frangit inertes,
Vimineasque trahit crates, juvat arva :

Much too he helps the field, who ev'ry clod
With harrows breaks, and drags the hurdle's load.

Equivocus accuses me for disliking harrowing and hurdling generally, when I only blame the method used by our worst Virgilians of scratching the superficies of the land, instead of tilling the staple of it, which, if it were well tilled, there

would be no clods to occasion the trouble, and (if the land be moist) the damage of harrowing. But, I believe, nobody ever denied, as he would insinuate, that harrowing or hurdling is necessary for covering of sown corn, or grass-seeds, except such corn as is sown under furrow.

This way of tilling the land with harrows, recommended by the poet, seems to show his husbandry was degenerated from that of the old Romans, who said, *Male subactum agrum qui occandus sit*. Col. That field is ill tilled that wants harrowing.

A yet worse contrivance it was, to till land with a hurdle made of vine twigs, this is so puerile an invention, that he might have directed it to be drawn by a hobby-horse.

A late commentator interprets this harrowing and hurdling to be of use in sowing upon the back; that is, upon once ploughing; had this interpretation been omitted, Virgil might have been thought not to have amassed together every one of the very worst pieces of husbandry that could be met with in any age or country.

Rursus in obliquum* verso perrumpit aratro,

Assails oblique, and thorough cuts again.

This is found not to attain the end of tillage near so well, as turning the furrows back again into the same places where they were before breaking up, and not to plough across the

* Whilst the green side of the furrow, which is turned downwards by the first ploughing, is rotting, the root sides being upwards, sends up blades and stalks of grass from all the joints of roots exposed to the air; for every joint has both roots and stalks included in it, the open air kills the roots; but the stalks are killed for want of it; these reversed roots being become a new turf, (which is nourished by such roots as the thickness and largeness of the furrow protect from air,) will continue to grow and hold the earth together, until that be also turned downwards from the reach of the air. But in cross-ploughing, not half the furrows are turned, they are only heaped upon one another, and there the air keeps the grass alive for a long time; when that which is turned back the same way without crossing is all killed; and, being dead on both sides, will grow no more; and the land is much sooner brought into tilth this way than by cross-ploughing, as experience shows.

furrows until the third ploughing, and sometimes the fourth ; for it should not be cross-ploughed before the grass (or turf) is totally dead. This shows, that in those days Ceres did choose her favourites as many as are now chosen, not for their merits ; since the most slovenly husbandmen were honoured with her approbation.

In common fields the lands are generally so narrow, that they cannot be cross-ploughed ; neither is it ever necessary, where land is clean ploughed without (*scamna*) balks.

Equivocus says, "That if Virgil should be wrong, it is certainly no great fault in a poet, since authors in prose are sometimes guilty of worse."

I do not say, it is a great fault in Virgil to be wrong either as a poet or a husbandman ; I only think I prove that he is wrong in the latter capacity ; and I have not so much veneration for the authority of the prince of poets, as to think that right which my reason and experience convince me is wrong ; and I cannot help thinking the late commentator much in the right, when blaming Mr. Dryden's version, he says, that if you take from Virgil his figures, you take the club from Hercules ; neither can I dissent from Seneca in my opinion of the Georgics, because he, living nearer to Virgil's time, could better judge of the truth of them than Equivocus. Take Seneca's words in his 86th Epistle, Englished by Mr. Cowley in the notes on his Davidies, as follows, viz. "Virgil did look not upon what might be spoken most *truly*, but what most *gracefully* ; and aimed more at delighting his readers, than at instructing husbandmen."

Hence, I think, that one who writes on the same subject, with a quite contrary view, (as I have done,) his husbandry may, in that respect, be termed without arrogance Anti-Virgilian.

Humida solstitia atque hyemes orate serenas
Agricolæ :—

The solstice moist, serene the winter sky,
For this, ye swains, entreat the powers on high.

Here Equivocus makes heavy clamours against me, for advising to keep land moist by retaining the dews : he says, that some nights let fall no dews, but such nights are certainly very rare, and when they happen, there is the more need to preserve those dews that have fallen in the moist nights.

He says, that if I had the power of correcting the Liturgy, I would expunge the prayer for rain : but Equivocus, no doubt, means no other liturgy than that of Virgil to his god Augustus. Vid. Pref. to Sept.

Ignarosque viæ—miseratus Agrestis

Ingredere, et votis jam nunc assuesce vocari.

Virgil might have advised them to remedy, in some measure, the inconveniences of dry weather, by frequently hoeing the soil to open it, for the reception of the dews which moisten it, and refrigerate the roots in the night, after the scorching heats of the day ; since he knew that

Noctes lentus non deficit humor.

Distilling moisture ne'er deserts the night.

He might have advised an expedient to obtain in part the effects of *Hiemes serenæ*, viz., to plant the corn in such a manner that it might be protected from the injuries of cold winds and water, as in the chap. "Of Wheat" is described.

Ipsa dies alios alio dedit ordine Luna

Felices operum. Quintam fuge, &c.*

For various labours each revolving Moon

Gives happy days ; the fifth be sure to shun.

In my remark on this fancy of the moon, Equivocus accuses

* Black-acre is first sown, and on the right day of the moon to begin upon ; then continuing to sow, until in its turn white-acre is sown, on the worst day of the moon. Now what reason could the poet give, why white-acre sown on the worst day should prosper the better for black-acre's being sown on the best day ? Answer, his word ; for certainly no other oracle but Virgil's word could have obtained a place for any thing so unphilosophical as this (about the days of the moon) to stand among the Transactions of that illustrious Society, whose motto is *Nullius in Verba*.

me of using "all the opprobrious language I am able to bestow on Virgil (and his commentator);" but this is so false that I defy him to show any opprobrious language in my Essay.

It is also as false for him to assert, that I say, there is not "one useful truth discovered in the Georgic."

The trick of Equivocus is to quote falsely, as he doth very frequently, if not generally: he leaves out the word new, which quite changes the sense of my expression.

But although it should have been said, that Virgil had been the discoverer of no truth in his Georgic, the assertion had not been amiss; because he who writes of no truths but what he takes from books written a thousand years before him, cannot be a discoverer of it.

Equivocus excuses Virgil concerning the influence of the moon, as follows, "An error (if it may be called one) of which not only Virgil, (who is chiefly celebrated for his poetry), but also the ancient husbandmen, who wrote before and after him, were guilty; and was in all probability inserted by Virgil in compliance with the currency of the times, rather than out of any serious belief of its influence on planting or sowing."

This is a wonderful vindication of the veracity and sincerity of Virgil, for which the Virgilians are much obliged to his champion Equivocus, who is such a zealot of truth, if you will believe him. But it is plain that Equivocus pretends to have more faith in this error, than he says Virgil had, and defends it with his usual arguments, which require much patience for a man of common sense to read. Also in his Essays some works are directed to be done in the increase, and others in the decrease of the moon.

Yet, in his Essay of June, page 99, he says, "But whether the increase or decrease of the moon affects, it seems at present to be an antiquated as well as useless speculation."

Is this (the above quotation from Virgil) what the late commentator in his Preface calls, "An Appeal to Truth and Nature throughout all Ages of Mankind?" Must vain and idle superstition be thought true and natural, because it is old, though we know it to be false, and consequently against Nature? I am sure it is far from showing, that the foundation of the whole Georgic is truth; unless he left out this, and most of all the rest. For indeed I cannot find one new useful truth discovered in all the pages of the Georgic,* though he says, every page affords instances of such; therefore I agree with that commentator, that it is endless to enumerate instances of that kind; because I hold, that nothing cannot be numbered.

Hic segetes, illic veniunt felicius uvæ.

The harvest here, there vines more happy found.

Vines will grow as well, and better in strong land, but light land is more easily hoed, &c.

Vines will grow wherever corn will grow, if there be sufficient heat to ripen the grapes. And corn will grow wherever vines will.

Nonne vides, croceos ut Tmolus odores,
India mittit ebur, &c.

Do you not see how Tmolus his perfumes,
Her iv'ry India, soft Sabæan's gums,
How Pontus heady castor sends from far,
The Spaniard's steel,———

It was the six lines immediately preceding, that occasioned this my remark; for *cultusque habitusque locorum*, is that fond maxim that forbids all new improvements.

Et quid quæque ferat Regio, et quid quæque recuset.

This verse seems to forbid improvements by exotics, and if

* The natural habit of Truth is a plain dress; yet not suddenly found, being the daughter of Time, therefore the moderns have the advantage of the ancients.

it had been always observed, we should have had neither apples even in Herefordshire, nor cherries in Kent.

This rule Virgil endeavours to enforce by the reasons, or rather examples, mentioned in the four following lines, viz., *Nonne vides croceos*, &c. These reasons Equivocus, though he exclaims against me in a scurrilous manner for disapproving, yet after he has pretended to excuse Virgil again by a *licentia poetica*, disapproves them more severely than I have done, but in other words, in page 30, of the Preface to August, viz., “And what fool could not have said as much as “he has done? For had Virgil been serious, and wrote in “prose, he might have been deemed as mad as several “people do this author (*i. e.* horse-hoer); but poets sure “have a little more liberty to make use of flights in verse “than those who write in prose have.”

Now, I suppose, that every impartial reader will allow, that Equivocus himself has implicitly acquitted me of “either “not having understood Virgil’s meaning, or else wilfully “misrepresented it.” For if Virgil was neither sincere, nor serious, nor believed himself what he wrote, as his champion Equivocus urges in defence of Virgilian husbandry, how shall any body understand his meaning? Or if nobody but Equivocus understands it, how can any other wilfully misrepresent it? Or how should I, who am no critic, be certain of a poet’s meaning, which the critics among themselves differ about? Our critic Equivocus, against the opinion of all others, will have it, that where Virgil says, *Hoc imitandum arando*, by *putre solum*, Virgil means, *putridum solum*: but it is certainly absurd to conclude, with Equivocus, that the design of tillage is to imitate putrid, cold, watery land. He has also made bold to correct Dr. Trap’s translation of *male pinguis Arenæ*; changing barren sands to mouldered clods.

Virgil says, *putres-sulci* is the soil whereon to sow *medica* [luserne], and it is well known, that even in hot countries, that grass will not succeed on a watery staple: therefore his

putre solum is not *putridum solum*, but rather *molle*, or *mite solum*, a loose, mellow soil.

And Col. Lib. ii. cap. 2. explains what *putre solum* is, (speaking of the African land, he says,) *Atque ejusmodi terram pinguibus arenis putrem veluti cinerem solutam*, &c.

For my part, I have taken Virgil's meaning in the true sense, to the best of my own judgment. And do not think it worth while to enter into any dispute about it, unless it were of greater moment than I apprehend it to be : and so I leave Equivocus to expound it by a *licentia poetica*, the latitude of which I am not poet enough to determine the extent of.

But if Equivocus thinks the *licentia poetica* to be so very extensive, he should have wrote in verse to entitle himself to the benefit of the poets, as felons are entitled to the benefit of the clergy ; but then he must have taken care to write like a poet, as the felon must read like a clergyman.

In page 32 of the same Preface, he demands the reason why I find fault with one of the best authors of antiquity, whose husbandry has stood the test of so many ages ? To which he gives himself an answer as ridiculous as false. And then he goes on to say of me as follows, viz., "He might, indeed, have attacked a Bradley, or even a Woodward (as he has done) with very good success, but a Virgil is certainly an over-match for him ; and it is much to be wondered at, that Virgil's translator, who has so just a value for him, should let this great adept pass so long unobserved."

It is well known, that Virgil was bred a farrier, which we call a horse-doctor, which trade has generally in most countries annexed to it, that of a blacksmith : it doth not indeed appear, that he had both those trades ; but however, his farrier's trade was sufficient to take up his time in learning and practising it, until he went to Rome, and then he had something else to do than to plough ; therefore, the only time he was likely to have for ploughing, must be before he was arrived

at years proper for learning his trade, and most of that time, too, seems to have been spent in keeping goats or sheep, as many of the boys of our lower class of people do. However such an age, wherein even plough-boys that do nothing else but plough, are very incapable of making useful observations upon arable industry; so that Virgil could have little or no experience in it of his own, and must have taken what he wrote from books written by those authors who lived when agriculture was in its most imperfect state, as Hesiod, and the other Greeks did.

Virgil was born a poet, and undoubtedly the best [of the Latins] that ever wrote; but neither he, nor any other, I believe, was ever born a farmer: talents in husbandry must be acquired by long experience and diligent observations thereon; and he that will make any improvements therein, must sometimes deviate from the old beaten road of *Patrios cultusque habitusque locorum*, by way of trial.

By asserting, that Virgil's husbandry has stood the test of so many ages (1700 years) Equivocus contradicts the commentator he praises, who with great truth affirms, There is more of Virgil's husbandry put in practice in England at this instant, than in Italy itself: which is as much as to say, it has not stood the test even in Virgil's own country, but is there disused; and, I believe, if that matter were fully inquired into, it would appear, that it never was much practised or approved of about Rome, or any other part of Italy.

From the Agrarian laws also, the same may be inferred; for that small portion of land allotted to each family, in this Virgilian culture, would not have been sufficient to keep those families from starving.

And in my travelling through that country (I went the whole length of it by land) traversing the kingdom of Naples almost all over, and made a considerable stay in many places

thereof; and in about two years' time, I never could find or be informed of paring or burning, or of raftering, or of sowing corn without many ploughings there, and yet their land is not strong.

And, methinks, it looks very odd, that Equivocus, after he has affirmed that the husbandry of England has been for these 1700 years Virgilian, should, in page 2 of his Advertisement to his Vol. II., talk of "rousing our countrymen, if possible, " out of that fatal lethargy into which they have long fallen." What test is likely to have been made in such a country, if Equivocus speaks truth? Or if the Virgilian husbandry they had so long practised in their lethargy were right, why does Equivocus endeavour so obstreperously to rouse them out of it? But he seems to condemn the English Virgilian husbandry yet more in page 4 of his preface to July, when he affirms, that "the greatest part of the nation have been all along bewildered in dark uncertain paths, not having come into the " true notions in practice and theory till of late."

Note. Raftering is ploughing one furrow, and leaving another unploughed, which is at most but half a ploughing.

Thus burning the surface, and ploughing light land late, and but once or twice, and sometimes half ploughing it, make that scheme of bad husbandry that Virgil's translator justly imputes to him, and whom he would not wrong, having such a value for him; and herein he is warranted by the general practice of the southern parts of England, where the worst sort of Virgilian husbandry reigns, being in most other places exploded, except by those who adhere more to blind custom than to reason; and must of necessity be exploded, in those southern parts also, were it not for their vast tracts of downs, which maintain such extraordinary flocks of sheep that suffice to help them, as I am informed, to dung their once ploughed land twice over, which dung, with a great quantity of seed harrowed in among the high sharlock and other weeds, pro-

duces them crops so uncertain, that it is a rule amongst the farmers there, that the profit of sheep must pay their rent; and notwithstanding that, I hear of more farmers that break in that country than elsewhere. And one thing I am sure they will readily grant me, viz., that were all their downs taken away, they must either change their Virgilian husbandry on their arable land, or desert that Virgilian country; for without sheep, their land, with their sort of single tillage, would not produce corn either to pay rent or to maintain them in food.

This Virgilian husbandry being shown, its opposite is not to pulverise land by fire, nor put trust in dung and harrows to supply the place of the plough; but on the contrary, to give to every sort of land proper and sufficient tillage (the poorest requiring most) and to use only what dung we have, or can reasonably get in the properest manner, is that husbandry which I call Anti-Virgilian; of which my horse-hoeing scheme is a species.

When Equivocus pretends to prove by experience that Virgil's bad husbandry is best, he has recourse only to the experience of Virgilians, which proves no more than that Virgil's husbandry is Virgilian; and not that it is better than any one species of the Anti-Virgilian; but in truth every proper trial proves it to be worse.

Poetry, like music, is a very pleasant and innocent amusement of life; but we ought not to suffer our diversion to captivate our reason; and if we seriously consider the scope and design of the *Æneid* and *Georgic*, what opinion can we have of Virgil's regard for truth? Or if it be true, as Ruæus relates, that Virgil's advice and persuasions entailed perpetual slavery upon the bravest people in the world, we cannot but know what a patriot he was, and how his principles ought to be esteemed by all the lovers of liberty. And I do not think it any more injurious to Virgil's memory to say, that he was the best poet,

and the worst field husbandman, than it is to Tully's to say that he was the best orator and the worst poet.

Should any author in prose have given a caution to the Italian farmers against planting their lands with perfumes, ivory, frankincense, castor, or steel, would he not be thought very impertinent?

A late commentator upon Virgil's second Georgic says*, "He is certain the husbandry of England in general is Virgilian, which is shown by paring and burning the surface; by raftering and cross-ploughing; and that in those parts of England where the Romans principally inhabited, all along the southern coast, Latin words remain to this hour among shepherds and ploughmen in their rustic affairs; and what will seem more strange at first sight to affirm, though in fact it be really true, there is more of Virgil's husbandry put in practice in England at this instant, than in Italy itself."

It is my opinion, that the Italians, in changing Virgil's field husbandry†, have acted more reasonably than these English who retain it; because I think it impossible for any scheme in general to be worse. Mine differing from it in all respects, warrants me in calling mine Anti-Virgilian.

* In the preface to his Translation of the Second Georgic, page 16.

† When Virgil says,

———Glebaque versis

Æternum frangenda bidentibus,

He treats only of vineyard culture, not of the field husbandry.

CHAPTER X.

OF TURNIPS.

As far as I can be informed, it is but of late years that turnips have been introduced as an improvement in the field.

All sorts of land, when made fine by tillage, or by manure and tillage, will serve to produce turnips, but not equally : for chalky land is generally too dry (a turnip being a thirsty plant), and they are so long in such dry poor land before they get into rough leaf, that the fly is very apt to destroy them there; yet I have known them succeed in such land, though rarely.

Sand and gravel are the most proper soil for turnips ; because that is most easily pulverised, and its warmth causeth the turnips to grow faster, and so they get the sooner out of danger of the fly ; and such a soil, when well tilled and horse-hoed, never wants a sufficient moisture, even in the driest weather, and the turnips, being drilled, will come up without rain, and prosper very well with the sole moisture of the dews, which are admitted as deep as the pulverisation reacheth ; and if that be to five or six inches, the hottest sun cannot exhale the dews thence in the climate of England : I have known turnips thrive well in a very dry summer, by repeated horse-hoings, both in sand, and in land which is neither sandy nor gravelly.

When I sowed turnips by hand, and hoed them with a hand-hoe, the expense was great, and the operation not half performed, by the deceitfulness of the hoers, who left half the land unhoed, and covered it with earth from the part they did hoe, and then the grass and weeds grew the faster : besides, in

this manner a great quantity of land could not be managed in the proper season.

When I drilled upon the level*, at three feet intervals, a trial was made between those turnips and a field of the next neighbour's, sown at the same time, whereof the hand-hoeing cost ten shillings per acre, and had not quite half the crop of the drilled, both being measured by the bushel, on purpose to find the difference†.

In the new method they are more certain to come up quickly; because in every row half the seed is planted about four inches deep‡, and the other half is planted exactly over that, at the depth of half an inch, falling in after the earth has covered the first half. Thus planted, let the weather be never so dry, the deepest seed will come up; but if it raineth (immediately after planting,) the shallow will come up first; we also make it come up at four || times, by mixing our seed, half new and half old (the new coming a day quicker than the old); these four comings up give it so many chances for escaping the fly, it being often seen that the seed sown over night will be destroyed by the fly, when that sown the next morning will escape; and *vice versa*; § or you may hoe-plough

* It is impossible to hoe-plough them so well when planted upon the level, as when they are planted upon ridges; for if we plough deep near to the row, the earth will come over on the left side of the plough, and bury the young turnips; but when they stand in ridges, the earth will almost all fall down on the right side into the furrow in the middle of the interval.

† And I have since found that turnips on the same land, planted on ridges with six-foot intervals, make a crop double to those that are planted on the level, or even on ridges, with three feet intervals.

‡ Turnip-seed will come up from a greater depth than most other sorts of seeds.

|| I have seen drilled turnip-seed come up daily for a fortnight together, when it has not been mixed thus, the old with the new.

§ I have had the first turnips that came up all destroyed by the fly, and about a fortnight afterwards more have come up and been hoed time enough, and made a good crop.

them when you see the fly is like to devour them; this will bury the greatest part of those enemies; or else you may drill in another row, without new ploughing the land.

This method has also another advantage of escaping the fly, the most certain of any other, and infallible, if the land be made fine as it ought to be; this is to roll it with a heavy roller across the ridges, after it is drilled, and closing up the cavities of the earth, prevents the fly's entrance and exit, to lay the eggs, hatch or bring forth the young ones to prey upon the turnips, which they might entirely devour if the fly came before they eat more than the first two leaves, which, being formed of the very seed itself, are very sweet; but the next leaves are rough and bitter, which the fly does not love. I have always found the rolling disappoint the fly, but very often it disappoints the owner also, who sows at random; for it makes the ground so hard that the turnips cannot thrive, but look yellow, dwindle, and grow to no perfection, unless they have a good hoeing soon after the leaves appear; for when they stand long without it, they will be so poor and stunted, that the hand-hoe does not go deep enough to recover them; and it is seldom that these rolled turnips can be hand-hoed at the critical time; because the earth is then become so hard that the hoe will not enter in, without great difficulty, unless it be very moist, and very often the rain does not come to soak it until it be too late; but the drilled turnips being in single rows, with six-feet intervals, may be rolled without danger: for the ground never so hard, and the hand-hoe will easily single them out, at the price of sixpence per acre or less (if not in harvest), and the horse-hoe will in those wide intervals plough at any time, wet or dry, and though the turnips should have been neglected till stunted, will go deep enough to recover them to a flourishing condition.

Drilled turnips, by being nowhere but in the rows, may be more easily seen than those which come up at random, and

may therefore be sooner singled out by the hand-hoe ; which is another advantage ; because the sooner* they are so set out, the better they will thrive.

Drilled turnips coming all up nearly in a mathematical line, it is very rarely that a charlock or other like weed comes up in the same line, amongst them, unless it be drilled in with the turnip-seed, of which weeds our horse-hoed seed never has any ; there being no charlock in the rows, nor any turnip in the intervals ; we know that whatever comes up in the interval is not a turnip, though so like it, that at first coming up, if promiscuously, it cannot easily be distinguished by the eye, until after the turnips, &c. attain the rough leaf, and even then before they are of a considerable bigness, they are so hard to be distinguished by those people who are not well experienced, that a company of hand-hoers cut out the turnips by mistake, and left the charlock for a crop, of a large field of sown turnips. Such a misfortune can never happen to drilled turnips, unless wilfully done, be they set out ever so young.

Young turnips will enjoy the more of the pasture made by the ploughing, and by that little pulverisation of the hand-hoe, without being robbed of any pasture by their own super-numerary plants.

Three or four ounces of seed is the usual quantity to drill ; but at random, three or four pounds is commonly sown, which coming thick all over the ground, must exhaust the land more than the other, especially since the sown must stand longer before the hoers can see to set them out

The six-feet ridges, whereon turnips are drilled in single

* The sooner they are made single the better ; but yet when they are not very thick, they may stand till we have the best convenience of singling them, without much damage ; but when they come up extraordinary thick, it will be much more difficult to make them single, if they are neglected at their very first coming into rough leaf.

rows, may be left higher than for double rowed crops; because there will be more earth in the intervals, as the single row takes up less.

There is no prefixed time for planting turnips; because that must be according to the heat or richness of the land; for some land will bring them as forward, and make them as good, when planted the beginning of August, as other land will when planted in May; but the most general time is a little before, and a little after midsummer.

Between these rows of turnips, I have planted wheat in this manner, viz., about Michaelmas, the turnips being full grown, I ploughed a ridge in the middle of each of their intervals, taking most of the earth from the turnips, leaving only just enough to keep them alive; and on this ridge drilled my crop of wheat*, and towards the spring pulled up my turnips, and carried them off for cattle.

As I have formerly drilled wheat between rows of turnips; so I have since had the experience of drilling turnips between rows of barley and rows of oats, as mentioned in my Preface. I have had them in the intervals between six-foot ridges, and between four-foot ridges, and between those of several intermediate distances; but which of them all is the best, I leave at present undetermined. I shall only add, that the poorer the land is, the wider the intervals ought to be; and that in the narrow it is convenient at the hoeing to leave more earth on that side of each interval, whereon the turnips are to be drilled; and this is done by going round several intervals with the hoe-plough, without going forwards and backwards in each immediately; but in the wide intervals the earth may be equal on both sides of them.

* This wheat being thus drilled on the new ridges, made in the intervals between the rows of turnips, being well horse-hoed in the spring, proved a very good crop; it was drilled in treble rows, the partitions seven inches each.

I will propose another method of drilling, which may be very advantageous to those who sow their barley upon the level, and sow turnip-seed amongst it at random, as they do clover, which is of late a common practice in some places. The barley keeps the turnips under it, and stunts them so much, that they are useful in the winter or spring chiefly by the food their leaves afford to sheep, their roots being exceeding small; and for this small profit they lose the time of tilling the ground, until after the turnips are eaten off, which is a damage the Anti-Virgilians think greater than the profit of such turnips. To prevent which damage they may drill them in rows at competent distances, and horse-hoe them, and set them out as soon as the barley is off: this will both keep the ground in tilth fit for another crop of spring corn, and cause the turnips to grow large enough (especially if harvest be early, and the winter prove favourable) for feeding of sheep in a moveable fold to dung the ground into the bargain.

What induces me to propose this improvement is, that a gentleman ploughs up his barley-stubble and transplants turnips therein, and hand-hoes them with success. By the proposed way all the expense of transplanting (which must be considerable) will be saved; and the setting out cannot be more than an eighth of the labour of hand-hoeings; and I conjecture the horse-hoed turnips may be as good; for they, though stunted, having their tap-roots remaining unmoved below the staple of the land, their horizontal roots being supplied with moisture from the tap-roots, immediately take hold of the fresh ploughed earth, as soon as it is turned back to them: whereas the transplanted having their tap-roots broken off, and their horizontal roots crumbled in the holes wherein they are set, must lose time, and be in danger of dying with thirst, if the weather proves dry.

Also this way seems better than the common practice of

sowing turnips upon once ploughing after wheat; because the wheat land commonly lies longer unploughed by six or eight months than barley land; and therefore cannot be in so good tilth for turnips as barley land may, unless the former be of a more friable nature, or much more dunged than the latter. Besides these wheat-turnips are uncertain, in respect of the fly that often destroys them at their first coming up, which misfortune happened the autumn 1734, to almost all that were sown in that manner.

I have observed that barley sown on the level, and not hoed, overcomes the turnips that come up amongst it; but that turnips which come up in the partitions of treble rows of my ridges of horse-hoed barley, grew so vigorously, as to overcome the barley. And this was demonstrated at harvest in a long field, one side of which had borne turnip-seed, and the drilled ridges of barley crossing the middle of it, and both ends of the field having barley sown on the level, one end of every ridge crossed the turnip-seed part of the field for about ten perch of their length.

I observed also that the turnips near the edges of the lands of sown barley, adjoining to the hoed intervals, grew large, but not so large as those in the partitions on the ridges, their intervals being hoed on each side of them.

But different from this have I seen shattered turnip-seed coming up in the like partitions of drilled wheat, on the very same sort of land, so miserably poor and stunted, that they scarce grew a hand's breadth high, when those turnips which the hoe left in the sides of the intervals, and at the narrow edges of the unhoed earth of the interval sides of the rows of wheat, grew large; and the wheat was good also. But I do not remember how the middle row of it succeeded.

This last experience of the turnips among the wheat was got by this accident: The wheat was drilled after drilled turnips on ridges of a different size. The turnips were all pulled

up before the ground was ploughed for the wheat; but as turnip-seed never comes all up the first year, enough remained of this to come up (though thinly) in the wheat, to show exactly where every row had been drilled; whereupon the observation was made.

When turnips are planted too late to have time and sun for attaining to their full bulk, some drill a double row, on each six-feet ridge, with a partition of fourteen inches; but I am told, that in this double row the turnips do not, even at that late season, grow so large as those planted at the same time in single rows; though the double row requires double the expense in setting out; and there will be less earth hoed by the breadth of fourteen inches of the deepest part of the ridge; and consequently the land will be the less improved for the next crop. We need not to be very exact, in the number* or distance† we set them out at. We contrive to leave the master-turnips (when there is much difference in them), and spare such when near one another, and leave the more space before and behind them; but if there be three master-turnips too near together, we take out the middlemost.

Turnips that were so thick as to touch one another when half grown by means of well hoeing their wide intervals, have afterwards grown to a good bigness, and by thrusting against one another became oval instead of round.

It is beneficial to hoe turnips (especially the first time) alternately, viz. to hoe every other interval, and throw the earth back again, before we hoe the other intervals; for by

* The least number will be the largest turnips, yet we should have a competent stock, which I think is not less than thirty on a square perch.

† The distance need not to be regular, for when a turnip has six inches of room on one side, and eighteen inches on the other side, it is almost as well as if there was one foot on each side; though then it would be equally distant from the two turnips between which it stood.

this means the turnips are kept from being stunted; it is better to have nourishment given them moderately at twice, than to have it all at once, and be twice as long before a repetition*.

Because this alternate hoeing does not at all endanger the roots, by being dried by the sun; for whilst one half of the roots have moisture, it is sufficient, the other half will be supplied from those, so that they will soon take hold of the earth again after being moved by the hoe.

Though the earth on each side the row be left as narrow as possible†, yet it is very profitable to hoe that little with a bidens‡, called here a prong-hoe, for this will be sure to let out all the roots into the intervals, even such as run very nearly parallel to the rows.

Some of these prong-hoes have three teeth, and are reckoned better as a tridens than a bidens; but this is only in mellow ground.

This alternate way of hoeing plants, that grow in single rows, is of such vast advantage, that four of these, which are but equal to two of the whole hoeings in labour, are near equal to four whole hoeings in benefit; for when one side is well nourished, the other side cannot be starved§.

Besides, where a great number of turnips are to be hoed, the last hoed may be stunted, before the first are finished by whole hoeings.

In this alternate hoeing, the hoe-plough may go deeper||,

* Sometimes, when turnips are planted late, this alternate hoeing suffices without any repetition; but when they are planted early, it will be necessary to hoe them again, especially if weeds appear.

† I do not think that we can go nearer to the plants with the hoe-plough, than within three inches of their bodies.

‡ We ought not to use the bidens for this purpose, before the perpendicular roots are as big as one's little finger.

§ But yet sometimes the weeds, or other circumstances, may make it proper to give them a whole hoeing at first.

|| This deep ploughing, so near to the row, is very beneficial at first;

and nearer to the row, without danger of thrusting it down on the left side, whilst the plants are very small; because the earth on the other side of the row always bears against it for its support. But in the whole hoeing, there is an open furrow left the first time on both sides of the row, and there is danger of throwing it into one furrow in ploughing the other; or if the row is not thrown down, it may be too much dried in hot weather, by the two furrows lying too long open. Yet when the turnips are large before hoeing, we need not fear either of these dangers in giving them a whole hoeing; as I have found by experience, even when there has been left on each side of the row only about three inches breadth of earth; though it is not best to suffer it to lie long open*.

Dry weather does not injure turnips when horse-hoed, as it does sown turnips; the hand-hoe does not go deep enough to keep the earth moist, and secure the plants against the drought, and that is the best season for horse-hoeing, which always can keep the roots moist.

But if some sorts of earth have lain so long unmoved as to become very hard before the first hoeing, the hoe going very near to the rows on each side, may cause such hard earth whereon the rows stand, to crack and open enough to let in the drought (*i. e.* the sun and air) to the roots in very dry weather. In this case it is best to horse-hoe alternately, as is directed in a preceding page.

but afterwards when the plants are grown large, and have sent their roots far into the intervals, it would almost totally disroot them; and they being annuals, might not live long enough for a new stock of roots to extend so far as is necessary to bring the turnips to their full bigness.

Note, At the last hoeing, we generally leave a broad deep trench in the middle of each interval.

* But, if the weather prove wet, we always suffer those furrows to lie open until the earth be dry enough to be turned back again to the row, without smearing or sticking together; unless such weather continue so long, that the weeds begin to come up, and then we throw back the furrows to stifle the weeds, before they grow large, though the earth be wet.

Dung and tillage together will attain the necessary degree of pulverisation, in less time than ploughing can do alone; therefore dung is more useful for turnips, because they have commonly less time to grow than other plants.

Turnips of nineteen pounds weight I have several times heard of, and of sixteen pounds weight often known; and twelve pounds may be reckoned the middle size of great turnips. And I can see no reason why every turnip should not arrive to the full bigness of its species, if it did not want part of its due nourishment.

The greatest inconvenience, which has been observed in the turnip husbandry, is when they are fed off late in the spring (which is in many places the greatest use of them) there is not time to bring the land in tilth for barley, the loss of which crop is sometimes more than the gain of the turnips: this is entirely remedied by the drilling method; for by that, the land may be almost as well tilled before the turnips are eaten, or taken off, as it can afterwards.

If turnips be sown in June, or the beginning of July, the most experienced turnip-farmers will have no more than thirty to a square perch left in hand-hoeing, and find that when more are left, the crop will be less; but in drilling the rows at six-feet intervals, there may be sixty* to a perch; and the horse-hoe, by breaking so much more earth than the hand-hoe does, can nourish sixty drilled, as well as thirty are by the sowing method, which has been made appear upon trial; but, I think, about forty or forty-five better than sixty on a perch; and the number of plants should always be proportioned to the natural and artificial pasture which is to maintain them; and sixty turnips on a square perch, at five pounds each (which is but a third of the weight of the large

* Yet I think sixty too many, unless the soil be rich, and very well pulverised.

size of sheep turnips), make a crop of above eighty quarters to an acre*.

When turnips are planted late (especially upon poor ground) they may be a greater number than when planted early; because they will not have time enough of heat to enjoy the full benefit of hoeing, which would otherwise cause them to grow larger.

The greatest turnip improvement used by the farmer, is for his cattle in the winter; one acre of turnips will then maintain more than fifty of meadow or pasture ground.

It is now so well known that most cattle will eat them, and how much they breed milk, &c., that I need say nothing about it.

Sheep always refuse them at first, and unless they have eaten them whilst they were lambs, must be ready to starve before they will feed on them; though when they have tasted them, they will be fatted by them. And I have seen lambs of three weeks old scoop them prettily, when those of a year old (which are called tegs) have been ready to die with hunger amongst them; and for three or four days would not touch them, but at last eat them very well.

In some places, the greatest use of turnips (except for fattening oxen and sheep) is for ewes and lambs in the spring, when natural grass is not grown on poor ground; and

* I have had turnips upon poor undunged land that weighed fourteen pounds a-piece; but these were only such as had more room than the rest. I have seen a whole wagon-load of drilled turnips spread on the ground, wherein I believe one could not have found one that weighed so little as six pounds; or if the rows had been searched before they had been pulled up, they would have weighed seven or eight pounds a-piece one with another; we weighed some of them that were thirteen, some fourteen pounds each, and yet they stood pretty thick. There might be, as I guess, about fifty on a square perch; but this crop was on sandy land not poor, and was dunged the third or fourth year before, and had every year a hoed crop of potatoes, or wheat, until the year wherein the turnips were planted.

if the artificial grass be then fed by the common manner, the crop will be spoiled; and it will yield the less pasture all the summer. I have known farmers, for that reason, obliged to keep their ewes and lambs upon turnips (though run up to seed) even until the middle of April.

There are now three manners of spending turnips with sheep, amongst which I do not reckon the way of putting a flock of sheep into a large ground of turnips without dividing it; for in that case the flock will destroy as many turnips in a fortnight, as would keep them well a whole winter.

The first manner now in use is, to divide the ground of turnips by hurdles, giving them leave to come upon no more at a time than they can eat in one day, and so advance the hurdles farther into the ground daily, until all be spent; but we must observe, that they never eat them clean this way, but leave the bottoms and outsides of the turnips they have scooped in the ground. These bottoms people pull up with iron crooks, made for that purpose; but their cavities, being tainted with urine, dung, and dirt from their feet, though the sheep do eat some of the pieces, they waste more, and many the crooks leave behind in the earth; and even what they do eat of this tainted food, cannot nourish them so well as that which is fresh and cleanly.

The second manner is, to move the hurdles every day, as in the first; but that the sheep may not tread upon the turnips, they pull them up first, and then advance the hurdles as far daily as the turnips are pulled up, and no farther. By this means there is not that waste made as in the other way; the food is eaten fresh and clean, and the turnips are pulled up with less labour than their pieces can be*.

* I have seen three labourers work every day with their crooks, to pull up these pieces, which was done with much difficulty, the ground being trodden very hard by the sheep; when one person, in two hours' time, would have pulled up all the whole turnips daily, and the sheep would have

The third manner is, to pull them up, and to carry them into some other ground in a cart, or wagon, and there spread them every day, on a new place, where the sheep will eat them up clean, both leaf and root. This is done when there is land not far off which has more need of dung than that where the turnips grow, which perhaps is also too wet for sheep in the winter, and then the turnips will, by the too great moisture and dirt of the soil, spoil the sheep, and in some soils give them the rot ; yet such ground will bring forth more and larger turnips than dry land ; and when they are carried off and eaten on ploughed ground in dry weather, and on greensward in wet weather, the sheep will thrive much better ; and that moist soil, not being trodden by the sheep, will be in much the better order for a crop of corn. And generally the expense of hurdles and removing them being saved, will more than countervail the labour of carrying off the turnips.

These three ways of spending turnips with sheep are common to those drilled, and to those sown in the random manner ; but they must always be carried off for cows and oxen ; both which will be well fattened by them and some hay in the winter. The management of these is the business of a grazier.

eaten them clean ; but so many of those pieces were dried and spoiled, that after the land was sown with barley, they appeared very thick upon the surface, and there could not be much less than half the crop of turnips wasted, notwithstanding the contrivance of these crooks.

CHAPTER XI.

OF WHEAT.

THOUGH all sorts of vegetables may have great benefit from the hoe, because it supplies them with plenty of food, at the time of their greatest need, yet they do not all equally require hoeing; but the plant that is to live the longest, should have the largest stock of sustenance provided for it: generally wheat lives, or ought to live, longer than other sorts of corn; for if it be not sown before spring, its grain will be thin, and have but little flour in it, which is the only useful part for making bread. And when sown late in the winter, it is in great danger of death from the frost, whilst weak and tender, being maintained (as a foetus) by the umbilical vessels, until the warmth of the sun enables it to send out sufficient roots of its own to subsist on, without help of the ovum.

To prevent these inconveniences, wheat is usually sown in autumn; hence, having about thrice the time to be maintained that spring corn hath, it requires a larger supply of nourishment, in proportion to that longer time; not because the wheat in its infancy consumes the stock of food, during the winter, proportionably to what it does afterwards; but because, during that long interval between autumn and spring seed-times, most of the artificial pasture is naturally lost, both in light and in strong land.

For this very reason is that extraordinary pains of fallowing and dunging the soil, necessary to wheat; though, notwithstanding all that labour and expense, the ground is generally grown so stale by the spring, and so little of the benefit of that chargeable culture remains, that, if part of the same field

be sown in the beginning of April, upon fresh ploughing, without the dung or year's fallow, it will be as great or a greater crop, in all respects, except the flour, which fails only for want of time to fill the grain.

Stale is a term for ground that has lain for some considerable time unploughed and unmoved; and is also used, as well as in this case, for ground that lies a time after ploughing before it is sown; and is contrary to that which is sown or planted immediately after ploughing.

The word *Fresh*, when joined with ploughing, is a term opposite to *Stale*, which is explained in the preceding paragraph, though it be there joined with the word *ground*.

It has also sometimes another signification when joined with the word *ground*; as *fresh ground*, is that which is ploughed up after not having been used as arable for several years. But such land as hath not been arable for a great number of years is more commonly called *new broke ground*.

Poor light land, by the common husbandry, must be very well cultivated and manured, to maintain wheat for a whole year, which is the usual time it grows thereon; and if it be sown late, the greatest part of it will seldom survive the winter, on such land; and if it be sown very early on strong land, though rich, well tilled and dunged, the crop will be worse than on the poor light land sown early. So much do the long winter's rains cause the earth to subside, and the divided parts to coalesce and lock out the roots from the stock of provision, which though it was laid in abundantly at autumn, the wheat has no great occasion of, until the spring, and then the soil is become too hard for the roots to penetrate; and therefore must starve (like Tantalus) amidst dainties, which may tempt the roots, but cannot be attained by them.

But the new method of hoeing gives, to strong and to light land, all the advantages, and takes away all the disadvantages

of both, as appears in the Chapters of TILLAGE, and HOEING. By this method the strong land may be planted with wheat as early as the light (if ploughed dry), and the hoe plough can, if rightly applied, raise a pasture to it, equal to that of dung, in both sorts of land.

Because the hoe may go in it all the year, and the soil being infinitely divisible, the division which the hoe may make whilst the crop is growing, added to the common tillage, may equal, or even exceed, a common dressing with dung, as I have often experienced.

About the year 1701, when I had contrived my drill for planting St.-Foin, I made use of it also for wheat, drilling many rows at once, which made the work much more compendious, and performed it much better than hands could do; making the channels of a foot distance, drilling in the seed and covering it, did not in all amount to more than sixpence per acre expense, which was above ten times over-paid by the seed that was saved; for one bushel to an acre was the quantity drilled; there remained then no need of hand-work, but for the hoeing; and this did cost from half-a-crown to four shillings per acre. This way turned to a very good account, and in considerable quantities; it has brought as good a crop of wheat on barley stubble, as that sown the common way on summer fallow; and when that sown the old way, on the same field on barley stubble, entirely failed, though there was no other difference but the drilling and hoeing. It was also such an improvement to the land, that when one part of a strong whitish ground, all of equal goodness, and equally fallowed and tilled, was dunged and sown in the common manner, and the other part was thus drilled and hand-hoed without dung, the hoed part was not only the best crop, but the whole piece being fallowed the next year, and sown all alike by a tenant, the hoed part produced so much a better crop of wheat than the dunged part, that a stranger would have be-

lieved, by looking on it, that that part had been dunged which was not, and that part not to have been dunged which really was.

Scarcely any land is so unfit, and ill prepared for wheat, as that where the natural grass* abounds; most other sorts of weeds may be dealt withal when they come among drilled wheat, but it is impossible to extract grass from the rows, therefore let that be killed before the wheat be planted.

The six-foot ridges being eleven, on sixty-six feet, which is an acre's breadth, ought to be made lengthways of the field, if there be no impediment against it; and if it be a hill of any considerable steepness, then they must be made to run up and down, whether that be the length or breadth of the piece; for if the ridges should go across such a hill, they could not be well horse-hoed, because it would be very difficult to turn a furrow upwards, close to the row above it, or to turn a furrow downwards without burying the row below it; and even when a furrow is turned from the lower row, enough of the earth to bury that row will be apt to run over on the left side of the plough; unless it goes at such a distance from the row, as to give it no benefit of hoeing.

These ridges should be made straight and equal, and to make them straight† all good ploughmen know how; and they will be setting up marks to look at, plough in a line like the path of an arrow. But to make the ridges equal, it is necessary to mark out a number of them before you begin to plough, by short sticks set up at each end of the piece, and then if one ridge happen to be a little too broad, the next

* One bunch of natural grass, transplanted by the plough into a treble row of wheat, will destroy almost a whole yard of it.

† But if the piece be of such a crooked or serpentine form, that the ridges cannot well be ploughed straight the first time, it is best to drill it upon the level; and then the marking wheels may direct for making the rows all parallel and equidistant, which will guide the plough to make all the ridges for the next, and all the subsequent crops as equal.

may be made the narrower ; for if the plough comes not out exactly at the second stick, the two ridges may be made equal by the next ploughing, or by the drilling ; but if many contiguous ridges should be too wide or too narrow, it will be difficult to bring them all to an equality afterwards, without levelling the whole piece, and laying out the ridges all new.

The exact height of ridges which is best I cannot determine*, a different soil may require a different height, according to the depth, richness, and pulverisation of the mould. As wheat covets always to lie dry in the winter, so there is no other way to keep it so dry as these ridges ; for when they are after the first hoeing about eighteen inches broad, with a ditch on each side of almost a foot deep, the rain-water runs off such narrow ridges as fast as it falls, and much sooner† than it is possible for it to do from broad ridges.

This is the breadth the ridges are generally left at, when the furrows are hoed from them, and thrown into the intervals.

And the deeper the soil, the more occasion there commonly is of this high situation ; because such land is wetter, for the most part, than shallow land, where we cannot make the furrows so deep nor the ridges so high‡ as in deep land, for we must never plough below the staple. I see the wheat on these hoed ridges flourish, and grow vigorously in wet weather, when other wheat looks yellow and sickly.

The same wide interval, which is hoed between ridges the

* I find by measuring my wheat ridges in the spring, that none of them are quite a foot high, and some of them only six inches ; but I know not how much they have subsided in the winter, for they were certainly higher when first made.

† Water, when it runs off very soon, is beneficial, as is seen in watered meadows ; but where it remains long on, or very near the bodies of terrestrial plants, it kills them, or at least is very injurious to them.

‡ If we should make our ridges as high on a shallow soil, as we may on a deep soil, there would be a deficiency of mould in the intervals of equal breadth with those of a deep soil.

first time, with two furrows, must have had four furrows to hoe it on the level; or else the furrow that is turned from the row would rise up, and a great part of it fall over to the left hand, and bury the row; but when turned from a ridge it will all fall down to the right hand.

You must not leave the tops of the ridges quite so narrow and sharp for drilling of wheat, as you may for drilling turnips; wheat being in treble rows, but turnips generally in single rows*. This is our method of making ridges for the first crop of drilled wheat.

But the method of making ridges for a succeeding crop, after the former is harvested, is best performed as follows:— In making ridges for wheat after wheat, you must raise them to their full height, before you plough the old partitions, with their stubble, up to them; for if you go about to make the ridges higher afterwards, the stubble will so mix with the mould of their tops, that it may not only be a hinderance to the drill, but also to the first hoeing; because if the hoe-plough goes as near to the rows as it ought, it would be apt to tear out the wheat-plants along with the stubble.

In reaping, we cut as near as we can to the ground†, which is easily done, because the stalks all stand close together at bottom, contrary to those of sown wheat.

I find this stubble, when it is only mixed with the intervals,

* A single row taking up less of the breadth, may be afforded to have more of the ridge's depth; because it leaves the interval wider.

† When wheat is reaped very low, the stubble is no great impediment; and I do this when I am forced to enlarge the breadth of my ridges, or to change their bearing, as I do when I find it convenient for them to point crossways of the field instead of lengthways; as if one end of it be wetter than the other; for it is inconvenient that one end of a ridge should be in the wet part, and the other in the dry; because in that case we cannot hoe the dry end without hoeing the wet at the same time; and whilst we attend for the wet part to become dry, it may happen that the season for hoeing the whole (if the quantity be great) may be lost.

very beneficial to the hoeing of my wheat; but I know not whether it may be so in rich, miry land.

As soon as conveniently you can, after the crop of wheat is carried off (if the trench in the middle of each wide interval be left deep enough by the last hoeing), go as near as you can to the stubble with a common plough, and turn two large furrows into the middle of the interval, which will make a ridge over the place where the trench was; but if the trench be not deep enough, go first in the middle of it with one furrow; which, with two more taken from the ridges, will be three furrows in each interval; continue this ploughing as long as the dry weather lasts, and then finish by turning the partitions (whereon the last wheat grew) up to the new ridges, which is usually done at two great furrows. You may plough these last furrows, which complete the ridges, in wet weather.

It is the depth and fineness of this ridge that the success of our crop depends on; the plants having nothing else to maintain them during the first six months; and if for want of sustenance, they are weak in the spring, it will be more difficult to make them recover their strength afterwards so fully as to bring them to their due perfection. But ploughmen have found a trick to disappoint us in this fundamental part of our husbandry, if they are not narrowly watched; they do it in the following manner, viz., they contrive to leave the trench very shallow, and then in turning the two first furrows of the ridge, they hold the plough towards the left, which raises up the fin of the share, and leaves so much of the earth whereon the rows are to stand whole and unploughed; that after once harrowing there does not remain above two or three inches in depth of fine earth underneath the rows when drilled, instead of ten or twelve inches.

On a time, when my diseases permitted me to go into the wheat-field, where my ploughs were at work, I discovered this trick, and ventured to ask my chief ploughman (or rather

chief master) his reason for doing this in my absence, contrary to my directions? He magisterially answered, according to his own (and Equivocus's) theory, which servants judge ought to be followed before that of him they call master, saying, that as the roots of wheat never reached more than two or three inches deep, there was no need that the fine mould should be any deeper. But those shallow ridges, which were indeed too many, producing a crop very much inferior to the contiguous deep ridges, showed, at my cost, the mistake of my cunning ploughman.

It is true, that people who examine wheat-roots when dead, are apt to fall into this mistake; for when they are shrivelled up, and so rotten, that they break off very near to the stalk in pulling up; but if they are examined in their vigour at summer, with care, in a friable soil, they may be seen to descend as deep as the fine pulverised mould reacheth, though that should be a foot in thickness.

I took up a wheat-ear in harvest that had lain on the grass in wet weather, where the wind could not come to dry it, which had sent out white roots like the teeth of a comb, some of them three inches long; none having reached the ground, they could not be nourished from any thing but the grains, which remained fast to the ear, and had not as yet sent out any blade. It is unreasonable to imagine, that such a single root as one of these, when in the earth, from whence it must maintain a pretty large plant all or most part of the winter, should descend no farther than when it was itself maintained from the flour of the grain only.

To make a six feet-ridge very high, will sometimes require more furrows; as when the middle of the intervals are open, very wide, and deep, then six furrows to the whole ridge may be necessary, and they not little ones; and the season makes a difference, as well as the size of the furrows, for when the fine mould is very dry (which is best) it will much of it run to the

left-hand before the plough, and also more will run back again to the left after the plough is gone past it.

But when such ridges have been made for wheat, and the season continues long too dry for planting it, and the stubble not thrown up, we then plough one deep furrow on the middle of each ridge, and then plough the whole ridge at four furrows more, which will raise it very high. This way of re-ploughing the ridges, moves all the earth of them, and yet is done at five furrows.

The furrows necessary for raising up the ridges must be more or fewer, in regard to the bigness of them; because six small furrows may be less than four great ones. It is not best to plough the stubble up to the ridges, until just before planting (especially in the early ploughing,) because that will hinder the re-ploughing of the first furrows, which, if the season continues dry, may be necessary: sometimes we do this by opening one furrow in the middle of the ridge, sometimes two, and afterwards raise up the ridges again; and when they are become moist enough at top (the old partitions being ploughed up to them), we harrow them once (and that only lengthways) and then drill them.

But if once be not sufficient to level the tops of the ridges fit for the drill to pass thereon, as it always will, unless the two last hard furrows lie so high that all the three shares of the drill cannot reach to make their channels, and in this case you must harrow again until they can all reach deep enough. Also in some sort of land, that when drilled late and very moist, will stick to the shares like pitch or bird-lime, whereby the channels are in part left open by the drill-harrow, it must be harrowed after it is drilled, because it is necessary in such land to take off the common drill-harrow in order for a man to follow the drill with a paddle, or else a forked stick, with which he frees the sheets of the adhering dirt; this harrow being gone, much of the seed will lie uncovered, and then

must be covered with common harrows, unless a drill-harrow, which was not in use when my plates were made, be placed instead of that taken off: this, with its two iron tines, will cover the seed in this case much better than common harrows, and will be no hinderance to cleansing of the sheets, the legs by which this harrow is drawn being remote from them, placed at near the end of the plank; and note, that the most proper drill for this purpose is one that has only two shares standing a foot or fourteen inches asunder: this harrow serves for taking up the drill to turn it.

There is a necessity of ploughing the old partitions up to the new ridges, to support their other earth from falling down by the harrowing and drilling, which would else make them level.

Our ridges, after the first time of ploughing, excel common ridges of the same height; because these, though as deep in mould at the tops, have little of it tilled at the last ploughing; but ours, being made upon the open trenches, consist of new-tilled pulverised mould, from top to bottom.

It is a general rule, that all sorts of grain and seeds, prosper best, sown when the ground is so dry as to be broken into the most parts by the plough. The reason why wheat is an exception to that rule is, because it must endure the rigours of winter, which it is the better able to do by the earth's being pressed, or trodden harder and closer to it*, as it is when moved wet.

If wheat were as hardy as rye, and its roots as patient of cold, it might, no doubt, be sown in as dry a season as rye is, and prosper the better for it, as rye doth. This will appear,

* It is for that reason, that farmers drive their sheep over very light land, as soon as it is sown with wheat, to tread the (top or) surface of it hard; and then the cold of the winter cannot so easily penetrate, to kill the roots of the tender plants.

if wheat and rye be both sown in the same dry season, after the winter is over.

But as wheat requires to have the earth lie harder on, and about it, in the winter; so also it requires more dung (or somewhat else) to dissolve the earth about its roots, after the cold winter is past, than rye doth, whose roots never were so much confined.

It is another general rule, that all sorts of vegetables thrive best, when sown on fresh tilled ground, immediately after it is ploughed.

Wheat is an exception to this rule also; for it is better to plough the ground dry, and let it lie until the weather moistens it (though it be several weeks) and then drill the wheat: the harrows and the drill will move a sufficient part of the ground, which will stick together for defence of the small roots, during the winter, the rest of the mould lying open, and divided underneath until spring, to nourish them.

There is a sort of binding sand, that requires not only to be ploughed dry, but sowed dry also; or else the wheat will dwindle in the spring, and fail of being a tolerable crop.

But what I mean by dry ploughing, is not that the land should always be so void of moisture, as that the dust should fly: but it must not be so wet as to stick together*. Neither should we drill when the earth is wet as pap, it suffices that it be moist, but moister in light land, than in strong land, when we drill.

If the two furrows, whereon the treble row is to stand, be ploughed wet, the earth of the partitions must grow so hard by the spring, that the roots cannot run freely therein, unless there be dung to ferment and keep it open.

So we see a steep bank, made of wet earth, will lie fast for several years, when another made of the same earth dry, will

* But the drier it is ploughed the better.

moulder and run down very soon ; because its parts have not the cohesion that holds the other together, it continues open and more porous, and crumbles continually down.

I have seen trials of this difference betwixt ploughing dry, and ploughing wet, for planting of wheat, both in the old way and the drilling way, but most in the latter; and never saw any instance where the dry ploughing did not outdo the wet; if the wheat was not planted thereon before the earth was become moist enough at top.

And strong land ploughed wet in November, will be harder in the spring, than if ploughed dry in August; though it would then have three months longer to lie.

After rain, when the top of the ground is of a fit moisture for drilling, harrow it with two light harrows, drawn by a horse going in the furrow betwixt two ridges; once will be enough, the furrow being just broke to level, or rather smooth it for the drill.

Once harrowing is generally enough, but not always.

If the veerings * whereon the next crop is to stand, be ploughed dry, we may drill at any time during the common and usual wheat-seed time, that is proper for the sort of wheat to be drilled, and the sort of land, whether that be early or late, we may drill earlier but not later than the sowing farmers. But I have had good crops of wheat drilled at all times betwixt harvest and the beginning of November.

* The word veering is, I believe, taken from the seamen, and signifies to turn; it is the ploughman's term for turning two furrows towards each other, as they must do to begin a ridge; and therefore they call the top of a ridge a veering; they call the two furrows that are turned from each other at the bottom, between two ridges a henting, *i. e.* an ending; because it makes an end of ploughing ridges.

Our intervals wholly consist either of veerings or hentings; when two furrows are turned from the rows, they make a veering; when turned towards the rows, they are a henting, which is the deep wide trench, in the middle of an interval.

For the benefit of the middle rows, it is better not to drill wheat on strong land before the usual season; because the later it is planted, the more open the partitions will be for the roots of those rows to run through them in the spring: and yet if the earth of the partitions be ploughed very wet, though late, they may be harder in the spring, than those which are ploughed early and dry.

There is a sort of wheat called by some Smyrna wheat, it has a prodigious large ear, with many lesser (or collateral) ears, coming all round the bottom of this ear; as it is the largest of all sorts of wheat, so it will dispense with the nourishment of a garden, without being over-fed, and requires more nourishment than the common husbandry will afford it; for there its ears grow not much bigger than those of common wheat; this I believe to be, for that reason, the very best sort for the hoeing husbandry; next to this I esteem the white-cone wheat, then the grey-cone. I have had very good crops from other sorts, but look upon these to be the best.

It is said to grow mostly in some islands of the Archipelago, and some author describes it *Triticum spica multiplici*. There is another sort of wheat that has many little ears coming out of the two sides of the main ear; but this is very late ripe, and doth not succeed well here, nor is it liked by them who have sown it; yet I have had some ears of it by chance among my drilled wheat, which have been larger than those of any common sort. I have not as yet been able to procure any of the Smyrna wheat, which I look upon as a great misfortune: but I had some of it about forty years ago.

When wheat is planted early, less seed is required than when late; because less of it will die in the winter, than of that planted late, and it has more time to tiller*.

* To tiller is to branch out into many stalks, and is the country word that signifies the same with *fructicare*.

Poor land should have more seed than rich land, because a less number of the plants will survive the winter on poor land

The least quantity of seed may suffice for rich land that is planted early; for thereon very few plants will die: and the hoe will cause a small number of plants to send out a vast number of stalks, which will have large ears, and in these, more than in the number of plants, consists the goodness of a crop*.

Another thing must be considered, in order to find the just proportion of seed to plant; and that is, that some wheat has its grains twice as big as other wheat of the same sort, and then a bushel † will contain but half the number of grains: and one bushel of small-grained wheat will plant as much ground as two bushels of large-grained; for, in truth, it is not the measure of the seed, but the number of the grains, to which respect ought to be had in apportioning the quantity of it to the land.

Some have thought, that a large grain of wheat would produce a larger plant than a small grain, but I have full experience to the contrary. The small grain, indeed, sends up its first single blade in proportion to its own bulk; but afterwards becomes as large a plant as the largest grain can produce, *cæteris paribus*.

Farmers in general know this, and choose the thinnest smallest grained wheat for seed: and therefore prefer that which is blighted and lodged, and that which grows on new-broke ground, and is not fit for bread, not only because this thin wheat has more grains in a bushel; but also because such seed is least liable to produce a smutty crop, and yet brings grains as large as any.

* A too great number of plants do neither tiller nor produce so large ears, nor make half so good a crop, as a bare competent number of plants will.

† Our bushel contains seventy pounds of the best wheat.

I myself had as full proofs of this as can possibly be made in both respects.

It was from such small seeds that my drilled Lammas-wheat produced the ears of that monstrous length described in this Chapter. I never saw the like, except in that one year; and the grains were large also.

And as full proofs have I seen of thin seed wheat escaping the smut, when plump large-grained seed of the same sort have been smutty.

Equivocus is the only denyer (I have heard of) that a small grain of wheat will produce as large grains as any.

Six gallons of middle-sized seed we most commonly drill on an acre; yet on rich land, planted early, four gallons may suffice; because then the wheat will have roots at the top of the ground before winter, and tiller very much, without danger of the worms, and other accidents that late planted wheat is liable to.

If it is drilled too thick, it will be in danger of falling; if too thin, it may happen to tiller so late in the spring, that some of the ears may be blighted, yet a little thicker or thinner does not matter.

As to the depth, we may plant from half an inch to three inches deep. If planted too deep, there is more danger of its being eaten off by worms, betwixt the grain and the blade*; for as that thread is the thread of life during the winter (if not planted early), so the longer the thread is, the more danger will there be of the worms †.

* A wheat-plant, that is not planted early, sends out no root above the grain before the spring; and is nourished all the winter by a single thread, proceeding from the grain up to the surface of the ground.

† Because the worms can more easily find a thread that extends by its length to five or six inches depth, than one which reaches but one inch: and besides the worms in winter do not inhabit very near the surface of the ground; and therefore also miss the short threads, and meet with the long ones.

It is a necessary caution to beware of the rooks, just as the wheat begins to peep; for before you can perceive it to be coming up, they will find it, and dig it up to eat the grain; therefore you must keep them off for a week or ten days, and in that time the blade will become green, and the grain so much exhausted of its flour, that the rooks think it not worth while to dig after it.

But the rooks do not molest wheat that is planted before or a little after St. Michael; for then there remains corn enough in the fields, which is left at harvest above ground, that rooks prefer always before corn which must cost them the labour of digging to find it.

Of Partitions between double, treble, and quadruple Rows.

The double row has but one partition, and that is best to be used when the land is suspected to be full of the seed of such weeds as must be taken out by the hand-hoe; in this partition while they are young, those which come up in the very rows may be pulled out when they are grown to a proper bigness.

This partition I should choose to have a foot* wide, because I have had whole fields drilled, all at that distance, hand-hoed at the expense of four shillings per acre; and therefore, when there is but one foot in six, it ought to cost but a proportionable price per acre.

The common width of the two partitions of the treble row is either seven or eight inches each. To find out the best distance of planting these rows, I made one of the partitions six inches, and the other nine inches; and they being har-

* But the difference betwixt a foot and fourteen inches is so little, that it is scarce worth while to set a drill on purpose; but to plant these double rows at the common distance of fourteen inches, without altering the drill. Or if the middle row be planted we can easily chop it out along with the weeds in the spring, if we find it necessary.

rowed by a common harrow, whose tines covering the rows, sometimes from one side, sometimes from the other side, made those partitions yet more unequal; in these I observed all the spring time, that in most places that outside row which was nearest to the middle row, was less than the other outside row which is farther from it*: and that that least outside row was only equal to the middle row, the other much exceeding either of these, but yet there was not this difference in all places; because, perhaps, the hoe-plough did not in these places go so near to that row, on the side of the narrower partition, as it did to the other outside row.

I have for some years planted my treble rows at seven inches asunder, and find them succeed better than in wider partitions: I observe that the better the land is, either by nature or culture, the less difference there is between the middle row, and the two outside ones, both at seven inch and eight inch partitions. The greatest difficulty is to determine the most proper width of partitions; for if they are too narrow, then all the rows may suffer by injuring one another, before the time wherein they are supplied with fresh nourishment from the hoed intervals; and if the partitions are too wide, the middle row will suffer by the too great distance there is for its roots to pass through, before they can enter the intervals.

The reasons of adding the middle row were, first, as an alloy to the exuberance of the other two, when they were of the Lammas sort. Secondly, when I found it necessary for constant annual crops of wheat, to enlarge the intervals, and lessen the number of ridges, I thought proper to increase the number of rows on each ridge.

Thirdly, that when part of a row was trodden out by hunters, or torn out by any accident, there might remain two rows entire, for when such accidents should happen to a double row,

* This observation was before I planted my rows on high ridges.

only one remaining in such places might be too little between wide intervals.

But the only reason for the middle row, which latest experience shows to be valid, is for the alloy it makes to the too great luxuriousness of the other two rows; for now the ploughmen know how to hoe well, they never plough out any part of an outside row; and though we can, by raising the ridges higher, make the three rows pretty equal, yet this is not a proof that the three produce more than the two would do without the middle row, because that being left out, the one partition may be more deeply pulverised by the hand-hoe, and the weeds more easily taken out; and the two rows must have much more nourishment than when there is a middle row.

I have lately seen such demonstrations of the difference, that I purpose for the future to drill white cone wheat (which is the only sort I now plant) in double rows only, with a partition of a foot or fourteen inches.

In a large poor field, drilled with wheat in double rows, the partition not being confined, was unequal, and more unequal than is usual, even when the partition is the parting* space, as it was here. After this wheat was taken off, I observed by the strength of the stubble, that in those places where the partition happened to be but four or five inches, the stubble was as thick and as strong as where the partition was eighteen inches, or more; but where the rows came nearer together than four or five inches, so as to appear like one single broad row, the stubble was smaller and weaker.

* The parting space is that distance which the drill leaves betwixt the row it plants in going one way, and that row which it makes in returning back; this distance cannot be supposed to be so exactly equal in all places, as those distances which are confined, as being made betwixt the shares of the drill; for when the drill has two shares, the space or distance betwixt them cannot vary.

Hence it may be inferred, that where this partition was widest, it gave no more nourishment to the two rows (in summer) than what was balanced by the greater distance their roots had to pass, before they could reach through to the opposite intervals; and the wider this partition is, the fewer of the roots will pass through it; for the roots going every way from a plant, sometimes like the radii of a circle from its centre, each row, to each plant, in its opposite row being as a chord of an arch, the farther it is from each opposite plant, or centre, the fewer of the radii, or roots, will be intersected by that row.

This is from their sides; but roots go from a corn-plant in a hemisphere like the rays of a star.

But as for the rows that approached too near together, they were stunted at first, whilst they were young, (and before they could have the benefit of hoeing); for the two rows having then, as it were, no partition between them, could have but half the nourishment they would have had, if the partition had been wide enough to half maintain them in their infancy.

Because each row had nourishment from one side only, instead of two sides, which they would have had, if the partitions had been competent.

I have not as yet made a drill on purpose for quadruple rows, but I make some of those rows every year with my treble drill in this manner, viz., I take off the fore-hooper, and the drill plants fourteen inches asunder, and then the horse returning back, goes on one of these two rows, and plants one more row, betwixt the other two, and one on the outside, this makes a quadruple row; but then its partitions are always uneven, which gives a much better direction how wide to make the partitions than if they were even; for the farther these middle rows are from one another, the nearer they are to the outside rows, and the wider is the middle partition; but the nearer the middle rows are to one another, the farther they

must be from the outside rows. In this last case I observe, that the two middle rows, when very near together, weigh less than the one middle row on a ridge of equal height next adjoining; but in the other case when the middle rows are nearer, viz., at the distance of six inches from the outsides, their produce is much larger than one middle row. Hence I conclude, that quadruple rows should have six inches partitions, the ridges raised high in good ground well pulverised, to keep their plants from being stunted when young; and the land should be made pretty clean from weeds.

These three partitions being only eighteen inches, will not occasion a much greater breadth of ridges than treble rows, which have only two partitions.

Neither of the two middle rows in a quadruple row, planted on the level, is so good as the one middle row in a treble row, the partitions in both being seven inches; and there can be no other reason for that difference, but that the one middle row has only one partition, and one row to pass through on each side of it, before its roots reach into the two intervals; but each of the two middle rows have two partitions, and two rows on one side to pass, ere they reach the interval on that side; so that the single-middle row has the benefit of two intervals, and each of the double-middle rows has only the benefit of one interval.

This difference is also a proof, that the middle rows do receive nourishment from the intervals, for else the one middle row, and each of the two would be all equal.

If by the shallowness of the soil, the narrowness of the plough, or by any other cause, the furrows are too small to raise the ridges high enough at once, you must raise them higher at twice ploughing; or else expect that the middle row will be the less, for want of more pasture underneath it; because it must have narrow partitions, that it may be the nearer to the intervals, and therefore the pasture that is wanting, in

the partitions on each side, cannot be supplied but from below, until the roots reach the intervals.

The middle row must not be too numerous in plants; for then they will be the weaker, and less able to send out their roots into the intervals early in the spring; and, indeed, if the outside rows are too thick in plants, they will rob the middle row the more when young; and afterwards their roots will form the thicker hedges, to obstruct those of the middle row from passing so easily out of the partitions. I remember, that the roots of my row that I found had reached the interval at eighteen inches distance (which was then the full height of the plants) having first passed through another row in their way, both these rows were thin of plants; planted late, the land made very fine, being a friable soil, all which made some little amends for the want of ridges; this land being planted upon the level.

But yet I always find that ridges, by the advantages they have above the land that is level, do (*cæteris paribus*) bring the best crop, and are more easily managed*.

June 19, 1731. I could never, until this year, bring my middle rows to be any thing near equal to the outside rows, but now I have done it, both in the treble and quadruple.

The earth was all thrown out of the middle of the intervals before last harvest, being first well pulverised; then some time after harvest, this earth, when dry, was raised up

* It is no small advantage in this management, that whether the veering or the henting be left in the interval by the hoe-plough, all the furrows in a whole field lie continually open; so that the master cannot be cheated by his ploughmen, who might otherwise persuade him they ploughed deep when they plough shallow. But in common ploughing, all the furrows may be shallow, except the last two of every ridge, which has, perhaps, forty furrows. Thirty-eight of which lying always covered, it is not easy to know how deep they are ploughed; and of all the villanies of English plough-servants, this trick of ploughing too shallow has undone the most farmers.

to a pretty high ridge, in the middle of each interval, from whence it was taken ; and when the weather had made it sufficiently moist, the wheat was drilled thereon, with seven-inch partitions. This wheat flourished all the winter and spring, and the middle rows seem equal to the outside rows, by their colour and height, both in the triple and quadruple, all being much stronger than the adjoining sown crops, though on dunged fallows four times ploughed, and mine being without dung for many years past.

The deep pulverised mould keeps the plants strong in the winter and spring, which enables the middle row to send out its roots the more vigorously through the roots of the outside rows ; which rows, if they were on shallow mould, would bar in the roots of the middle row, because the roots are thickest near the stems.

When the plants of the middle row are too numerous for the pasture of the partitions, for want of a sufficient depth of pulverised earth, they are weak and unable to send out their roots vigorously enough to reach the intervals in time ; also when the plants of the outer row are too numerous on a shallow mould, the roots of these, which are always thickest near the bottom of the stems, make a *septum* or hedge betwixt the roots of the middle (or inner) row and the interval, this very much obstructs their passage ; but when the pulverised mould is deep under the outside row, then the roots of it are thinner below, and admit the roots of the middle row to pass through, among, and between them, there.

If the middle row did not receive benefit by its roots from one or both of the intervals, then a middle row that had partitions of eight or nine inches on a high ridge would exceed one that had partitions of seven inches, the former having more room on each side of it ; but it is just the contrary, for the latter exceeds the former, which it could not do, but from the nourishment it receives from the intervals.

But if the hoe-plough does not at the first hoeing go deep and near to the rows, the subsided earth will, especially in strong land, be as a wall to confine the roots of all the rows from entering the interval in the spring and summer, which is the time they require most nourishment from it.

Experience has shown me this year, that this is the reason that the middle row falls short of, or equals the outside row; for in about sixty acres of wheat I now have near ripe, there is not one row, whether triple or quadruple, wherein the middle row, or rows, do not succeed according as they are managed, by the one or the other method, viz., where any middle or inner row has a competent number of plants, standing on a competent thickness of sufficiently well pulverised earth, and its outside row the same whereunto the hoe-plough has gone deep and very near, such middle row equals the outside row; but wherever any of these circumstances are wanting, the middle row falls short more or less in proportion, as more or fewer of them are wanting. The middle row having more pasture underneath it, may stand the nearer to the outside rows, without being stunted in the winter or spring, and, therefore, may be as well and better nourished by seven-inch partitions, than by those much wider and thinner, though equally pulverised; and then being of equal strength, will send out its roots the sooner into the intervals, by how much it stands nearer to them. Besides, I find that seven-inch partitions may be hand-hoed early in the spring, and the rows being so near together, prevent the weeds from thriving in the partitions when they are not hoed; and when poppies do come in them, they always thrust out their heads into the intervals for air, and may be very easily pulled out.

The first hoeing is performed by turning a furrow from the row.

We are not so exact as to the weather in the first hoeing; for if the earth be wet the hoe-plough may go the nearer to

the row, without burying the wheat; and the frost of the winter will pulverise that part of the furrow, which is to be thrown to the wheat in the spring, although it was hoed wet.

The word furrow signifies the earth that is thrown out, as well as the trench from whence it is thrown by the plough.

Neither is it necessary to be very exact as to time, but it must never be until the wheat has more than one blade; and it may be soon enough, when it has four or five leaves, so that it is done before, or in the beginning of winter.

But if the wheat is planted very late, it may not be hoeable before the winter is past; nor is there is such a necessity of hoeing the late planted before the great frosts are over, as there is of the early planted; for the later it is planted the less time the earth has to subside and grow hard.

Note. By winter we do not mean only those months that are properly so reckoned, but also such other months which have hard frosts in them, as January, February, and sometimes the beginning of March.

The greatest fault you can commit in hoeing, is the first time, when the furrow is turned from the row, not to go near enough to it, nor deep enough. You cannot then go too near it, unless you plough it out or bury it with mould, and do not uncover it; nor too deep, unless you go below the staple of the ground.

Servants are apt to hoe too far from the rows, going backwards and forwards in the middle of the intervals, without coming near the rows; this loses most of the benefit of hoeing, and is very injurious to the present crop, and also to the two succeeding crops; for then there will be a deficiency of pulverised earth, and nobody can suppose that the hoed earth can be of any benefit to the rows before the roots reach into it; and when it is far off, few of the roots reach it at all, and those that do reach, come there too late to bring the plants to their full perfection; therefore, if the first furrow

was not near enough nor deep enough, plough a second furrow at the bottom of the former, which will go deeper than the first, and break the earth more, besides taking away from the rows such unmoved ground which the first ploughing may possibly have missed. If this cannot be conveniently done soon after the first hoeing, do it before the ridge is turned back in the spring.

Always leave the furrows turned up, to make ridges* in the middle of the intervals during the winter; and then the hollow furrows or trenches next the rows, being enriched by the frost† and rains‡, the wheat will have the benefit of them

* Though the ridge in the middle of the interval should, for want of sufficient mould, or otherwise, be too low to give shelter, yet there is generally some earth falls to the left of the hoe-plough, and lodges upon that part which is left on the outside of the row; which, notwithstanding that part be very narrow (as suppose two or three inches) yet a small quantity of earth lying thereon, so near to the outside row, gives an extraordinary shelter to the young wheat plants that grow in it.

Shelter is a great benefit to wheat, but yet nourishment is more; for in the winter I see the wheat plants upon the most exposed part of the ridge flourish, when single plants in the bottom of the furrow are in a very poor languishing condition, without any annoyance of water, they being upon a chalk bottom.

† Frost, if it does not kill the wheat, is of great benefit to it; water, or moisture, when it is frozen in the earth, takes up more room than in its natural state; this swelling of the ice (which is water congealed) must move and break the earth wherewith it is mixed; and when it thaws, the earth is left hollow and open, which is a kind of hoeing to it. This benefit is done chiefly to and near the surface; consequently the more surface there is by the unevenness of the land, the more advantage the soil has from the frost.

This is another very great use of the ridge left in the middle of the interval during the winter; because that ridge and its two furrows contain four times as much surface as when level. This thus pulverised surface turned in, in the spring hoeing, enriches the earth in proportion to its increase of internal superficies, and likewise proportionably nourishes the plants whose roots enter it; and that part of it wherein they do not enter, must remain more enriched for the next crop, than if the soil had remained level all the winter.

‡ It is a vulgar error that the winter rains do not enrich the earth, and is only thought so because we do not see the effect of them upon vege-

earlier in the spring, than if the trenches had been left open in the middle of the intervals.

The outside rows of wheat from which the earth is hoed off, before or in the beginning of winter, and left almost bare until the spring, one would think should suffer by the frost coming so near them*, or for want of pasture, but it appears to be quite contrary, for where the hoe has gone nearest to a row, its plants thrive best; the earth, which the frost hath pulverised, being within the reach of the young short roots, on that side of the row from the top to the bottom of the trench, nourishes them at first, and before the plants have much exhausted this, as they grow larger in the spring, the ridge from the middle of the interval is thrown to them, having a perfectly unexhausted pasture to supply their increasing bulk with more nourishment.

The row standing as it were on the brink of this almost perpendicular ditch, the water runs off quickly, or doth not enter but a very little way into this steep side; so that the earth at the plants being dry, the frost doth not reach quite to all their roots to hurt them, though the distance from the air to the roots be very short, and dry earth doth not freeze as wet doth, neither is this ditch much exposed to the cold winds.

The spring hoeing is performed after the great frosts are passed, and when the weather will allow it; and then turn †

tables, for lack of heat in that season. But some farmers have frequently observed, that one half of a ground ploughed up just before winter, has produced a crop of barley as much better than the other part ploughed up at the end of winter, as is the difference of a dunging, even when there has been very little frost.

* In very light land, perhaps, we must not hoe quite so near to the rows of wheat as in strong land, for fear the winter should lay the roots bare, and expose them too much to the cold; but then we may be sure that in this case the roots will reach the interval at a greater distance than in strong land; yet such very light land is not proper for wheat.

† It is an errant mistake of the vulgar, when they imagine that the im-

the ridge from * the middle of the interval to the rows on each side, by two furrows as near as can be, without covering the wheat; in doing which have regard to the row only, without looking at the middle of the interval; for it is no matter if a little earth be left there, the next hoeing, or the next save one,† will move it.

As to how many times wheat is to be hoed in the summer after this spring operation, it depends upon the circumstances‡ and condition of the land§ and weather||; but be the season as it will, never suffer the weeds to grow high, nor let any unmoved earth lie in the middle of the intervals long enough to grow hard; neither plough deep near the rows in the summer, when the plants are large¶, but as deep in the

mediate benefit of fresh earth to plants is from that part which remains uppermost; for it is from turning the impregnated pulverised side downwards, to be fed on by the roots, that gives the pabulum or nourishment of the fresh earth to plants, the other side being turned upwards, becomes impregnate also in a little time.

* But note, that when we see weeds coming up near the row in the spring, we plough again from the rows (and sometimes can plough within one inch of the row) before we turn down the mould from the middle of the interval.

† If at the next hoeing we turn another furrow towards the row (which is seldom done) then it is the next that moves the remaining earth left in the middle of the interval; but if the next hoeing be from the row (as it generally is) then that covers the middle of the interval, and then it is the next hoeing after that, that turns all the earth clean out of the middle of the interval toward the rows.

‡ If the land was not sufficiently tilled or hoed in the precedent year, it will require the more hoeings in the following year.

§ The poorer the land is, the more hoeings should it have.

|| A wet summer may prevent some of the hoeings that we should perform in a dry summer.

¶ Our hoeing deep near the plants when small, breaks off only the ends of the roots; but after the roots are spread far in the interval, the greatest part of them being then on the right-hand side of the hoe-plough, might hold fast on that side, and not be drawn out, and then the whole roots would be broken off close to the bodies of the plants; therefore at the second deep hoeing, that turns a furrow from the row in the summer, we go about four or six inches further off from the row than the time before;

middle of the intervals as the staple will allow; turning the earth towards the wheat, especially at the last hoeing, so as to leave a deep wide trench in the middle of each interval.

We augment our wheat crops four ways; not in number of plants, but in stalks, ears, and grains.

The first is by increasing the number of stalks from one, two, or three, to thirty or forty to a plant, in ordinary field land.

And we augment the crop, by bringing up all the stalks into ears, which is the second way; for if it be diligently observed, we shall find that not half* the stalks of sown wheat come into ear.

I saw an experiment of this in rows of wheat that were equally poor, one of these rows was increased † so much, as to produce more grains than ten of the other, by bringing up more of its stalks into ears, and also by augmenting its ears to a much greater bigness, which is the third way; for whatever Varro means by saying that the ears remain fifteen days in *vaginis*, it is pretty plain that the ears are formed together with the stalks, and will be very large or very small, in proportion to the nourishment given them.

Like as the vines, if well nourished, bring large bunches of grapes; but if ill nourished, they produce few bunches, and those small ones, and many clasps are formed, which would

but we go nearer or further off, according to the distance of time between those two hoeings; yet we may hoe shallow near to the plants at any time, without injury to their roots, but on the contrary, it will be advantageous to them.

* If a square yard of sown wheat be marked out, and the stalks thereon numbered in the spring, it will be found that nine parts in ten are missing at harvest.

† These rows were drilled a foot asunder, not hoed, and were, by the shallowness and wetness of the soil, very poor in the spring; and then, by pouring urine to the bottom of this row, it was so vastly increased above the rest.

have been bunches, if they had had sufficient nourishment given them at the proper time.

The last and fourth way of augmenting the produce of wheat plants, is by causing them to have large and plump grains in the ears; and this can no way be so effectually done, as by late hoeing, especially just after the wheat is gone out of the blossom, and when such hoed grains weigh double the weight of the same number of unhoed, (which they frequently will,) though the number of grains in the hoed are only equal, yet the hoed crop must be double.

Thus by increasing the number of stalks*, bringing more of them up into ear †, making the ears larger ‡, and the grain plumper and fuller of flour §, the hoeing method makes a

* The same plant that when poor sends out but two or three tillers, would, if well nourished by the hoe or otherwise, send up a multitude of tillers, as is seen in hoed wheat and sown wheat.

† Mr. Houghton relates eighty ears on one single plant of wheat, and a greater number has been counted lately in a garden; those eighty reckoned to have fifty grains a-piece, make an increase of four thousand grains for one: but I have never found above forty ears from a single plant in my fields; yet there is no doubt, but that every plant would produce as many as Mr. Houghton's of the same sort, with the same nourishment. But I should not desire any to be so prolific in stalks, lest they should fail of bringing such a multitude of ears to perfection. The four hundred ears, that I numbered in a yard, were not weighed, because they were told before ripe, and the greatest weight of wheat that ever I had from a yard, was the product of about two hundred and fifty ears, and some of them were small.

‡ I have numbered one hundred and nine grains in one ear of my hoed cone-wheat, of the grey sort. And one ear of my hoed Lammas-wheat has been measured to be eight inches long, which is double to those of sown wheat. I have some of these ears now by me, almost as long, the longest being given away as a rarity; and indeed it is not every year that they grow to that length, and it is always where the plants are pretty single. But there is no year wherein one ear of my hoed does not more than weigh two of the sown ears, taking a whole sheaf of each together without choosing. The sheaves of the hoed are of a different shape from the other; almost all the ears of the hoed are at the top of the sheaf; but most of the other are situate at the lower part, or near the middle of the sheaf.

§ Seed cone-wheat, coming all out of the same heap, planted all at the

greater crop from a tenth* part of the plants, than the sowing method can.

The fact of this nobody can doubt of, who has observed the different products of strong and of weak plants, how the one exceeds the other.

Equivocus, in his Advertisement to April, quotes authors who affirm, that a single grain of Smyrna wheat produced 9792 grains; one grain of barley 18,000, and one bean 1050 beans; but it is reckoned a very great increase, when our sown fields produce a ten-fold crop, that is, ten grains for one that is sown; which is 9782 less than the increase of wheat by that author related.

The greatest difference of having an equal crop from a small number of strong plants, and from a great number of weak ones, is, that the soil is vastly less exhausted by the former than by the latter, not only from the latter's exhausting more in proportion to their number when young, and while each of them consumes as much nourishment as each of the small number; but also from the different increase that a strong plant makes by receiving the same proportion of food with a weak one. For it appears from Dr. Woodward's experiments, that the plant which receives the least increase carries off the greatest quantity of nourishment in proportion to that increase; and that it is the same with an animal, all who are acquainted with fattening of swine know;

same time, and on land of the same sort, adjoining near together, the wheat that was sown produced grains so small, and that which was drilled so very large, that no farmer or wheat buyer would believe them to be of the same sort of wheat, except those who knew it, which were many. One grain of the drilled weighed two of the sown, and there was twice the chaff in an equal weight of the sown, being both weighed before and after the wheat was separated from the chaff.

* But though a too great number of plants be, upon many accounts, very injurious to the crop, yet it is best to have a competent number; which yet needs not be so exact, but that we may expect a great crop from twenty, forty, or fifty plants, in a yard of the triple row, if well managed.]

for they eat much more food daily for the first two weeks of their being put into the sty than they do afterwards when they thrive faster; the fatter they grow, the less they eat.

Hence, I think it may be inferred, that a plant, which by never having been robbed or stunted by other plants, is strong, receives a much greater increase from an equal quantity of food, than a number of weak plants (as thick ones are) equalling the bulk of the single strong plant do.

And this of the doctor's have I seen by my own observations confirmed in the field, in potatoes, turnips, wheat, and barley; a following crop succeeds better after an equal crop consisting of a bare competent number of strong plants, than after a crop of thick weak ones, *cæteris paribus*.

Thus the hoed crops, if well managed, consisting of fewer and stronger plants than the sown crops of equal produce, exhaust the ground less, whereby, and by the much (I had almost said infinitely) greater pulverisation of the soil, in different good land may, for any thing I have yet seen to the contrary, produce profitable crops always without manure or change of species, if the soil be proper for it in respect of heat and moisture; and also as crops of some species by their living longer by their greater bulk or different constitution, exhaust more than others, respect ought to be had to the degree of richness of the soil that is to produce each species.

The sowing and hoeing husbandry differ so much both in pulverisation and exhaustion, that no good argument can be drawn from the former against the latter, especially by Equivocus, whose works demonstrate him to be more ignorant of both than any author that (I believe) ever wrote of husbandry before him, and it is to be hoped that ever will after him; the design of Equivocus in writing being only to defame, not to instruct.

All these advantages will be lost by those drillers, who do not overcome the unreasonable prejudices of the inexperienced, concerning the width of intervals.

In wide intervals we can raise a good crop, with less labour, less seed, no dung, no fallow, but not without a competent quantity of earth, which is the least expensive of any thing given to corn. The earth of a whole good acre being but about the tenth part of the common expense; and of indifferent land the twentieth, and such I count that of five shillings and sixpence per acre.

The crop enjoys all the earth, for betwixt the last hoeing and the harvest there remains nothing but space empty of mould, in the middle of the intervals.

In our five-feet * intervals, it is not necessary that we keep the roots from passing through all the mould, (if the wheat be of a proper sort,) for they will always leave a sufficient pasture for a succeeding crop, because it is impossible for them to come into contact with it all in one year; but the more pasture is made by frequent hoeing the more will be left unexhausted.

It is an objection, that great part of those wide intervals must be lost because the wheat roots do not reach it; but as we generally turn the mould towards the row, at the last hoeings, there is no part of it above two feet distant from even the middle row, and seventeen inches from either of the outside rows.

They do reach through all the mould (as shall be proved by-and-by) and yet may leave sufficient pasture behind; because it is impossible for them to come into contact with all the mould in one year, no more than when ten horses are put into a hundred acres of good pasture, their mouths come into

* We call them five-feet intervals, though they are but four feet ten inches broad; these being the widest that we find are proper for wheat; but it is not to be imagined that we can be so exact, to make our ridges or intervals to an inch. Yet we make the ridges as exact as we can with the plough, and the intervals as even as we can, by guiding the drill exactly on the middle of the top of each ridge.

contact with all the grass to eat it in one summer, though they go all over it, as the vine roots go all over the soil of a vineyard without exhausting it all; because those roots feed only such a bare competent quantity of plants, which do not overstock their pasture.

The superficies of the fibrous roots of a proper number of wheat plants bear a very small proportion to the superficies of the fine parts of the pulverised earth they feed on in these intervals; for one cubical foot of this earth may, as is shown in p. 68, have many thousand feet of internal superficies. But this is in proportion to the degree of its pulverisation; and that degree may be such as is sufficient to maintain a competent number of wheat plants without over-exhausting the vegetable pasture, but not sufficient to maintain those, and a great stock of weeds besides, without over-exhausting it. And this was plainly seen in a field of wheat drilled on six-feet ridges, when the south ends of some of the ridges, and the north ends of others, had their partitions hand-hoed and cleansed of weeds early in the spring, the opposite ends remaining full of a small species of weeds, called crow-needles, which so exhausted the whole intervals of the weedy part of the ridges, that the next year the whole field being drilled again with wheat exactly in the middle of the last intervals, the following crop very plainly distinguished how far each ridge had its partitions made clean of those small weeds in the spring from the other end where the weeds remained till full grown. The crop of the former was twice as good as that of the latter, even where both were cleansed with weeds the next spring. This crop standing only upon that part of the mould which was furthest from the rows of the precedent crop, proves that the roots both of the wheat and weeds, did enter all the earth of the former intervals.

It was also observable, that where the partitions of two of the six-feet ridges had been in the precedent year cleansed of weeds, and those of the adjoining ridges on each side of them

not cleansed, the row that was the next year planted exactly in the middle of the intervals between those two ridges, was perceptibly better than either of the two rows planted in the intervals on the other side of each of them. The reason of which difference must be, that the middle of the interval that was between the two cleansed ridges was fed on by the wheat only, and by no weeds; but the other two intervals were fed on by the wheat on one side, and by both the wheat and the weeds on the other side of each.

There were in the same field several ridges together that had the ends of their rows of wheat ploughed out by the hoe-plough, and their other ends cleansed of weeds. This was done on purpose to see what effect a fallow would have on the next crop, which was indeed extraordinary; for these fallowed ends of the ridges being horse-hoed in the summer, as the other ends were, and the intervals of them made into ridges, the following year produced the largest crop of all; this crop was received in 1734.

These several different managements performed in this field, showed by the different success of the crops in each sort, what ought to be done, and which is the best sort of management.

This field, indeed, is some of my best land; and by all the experiments I have seen on it, I do not find but that by the best management never omitted in any year, it might produce good annual crops of wheat always, without assistance of dung or fallow; but it would be very difficult for me to get hands to do this to the greatest perfection, unless I were able constantly to attend them.

But now it being thus proved, that the mould of my widest intervals, that lies the furthest off from the partitions, is exhausted by the roots of the small weeds that grow in the partitions, and also by the roots of the wheat of the rows; what can be the sense of Equivocus when he affirms in pages 37 and 38 of his Essay for July, that at the distance I put my rows of wheat, I may drill over a field for five or six years running, without

ever putting it in one and the same place? But this gross error proceeds from his ignorance of the nature of roots, and of the proportion they bear to the other parts of their respective plants, imagining, with my ploughmen, that the roots of wheat extend not above two or three inches from the stalks, though the above experiment proves that the roots both of the wheat and weeds had exhausted that part of the mould of the six-foot ridges that was the furthest off from the rows, else the wheat that was drilled where only wheat grew on each side of the precedent year's intervals, would have been no better a crop than that where grew wheat and weeds too; neither would that wheat whose mould whereon it stood had neither wheat nor weeds on either side of it the precedent year, have been the strongest of all. These intervals were four feet ten inches wide, the two partitions of the triple rows being seven inches wide each.

The whole pulverised earth of the interval being pretty equally fed on by the former crop, it is no matter in what part of it the following crop is drilled: I never drill it but on the middle of the last year's interval, because there is the trench whereon the next year's ridge is made with the greatest conveniency. But there may be some reason to suspect that the plants of the rows exhaust more nourishment from that earth of the intervals which is furthest from their bodies, than from that which is nearest to them, since their fibrous roots at the greatest distance from the roots are most numerous. By these the plants, when at the greatest bulk, are chiefly maintained.

It must be noted, that the above experiments would not have been a full proof, if the weeds had been suffered to grow in the partitions of the more exhausted ends in those ridges, in the year wherein the difference appeared.

It may also be noted, that a mixture and variety of bad husbandry are useful for a discovery of the theory and prac-

tice of good husbandry ; but it is a great misfortune that our servants are apt to show us the experiments of the bad, in greater quantities than is for our profit, for since their authority over us is become absolute, their will is our law ; and though they let us see that they can do one as well as the other when they please, we must be content with that quantity of each which they think proper to do for us ; unless we can manage our agriculture with our own proper hands, and with the product of our land and labour maintain that class of people in idleness and luxury.

But for Equivocus to pretend to write a general system of Agriculture without any competent knowledge of roots (of which he shows himself perfectly ignorant), is as presumptuous as if he should pretend to a great mathematician and surveyor without understanding the four first rules in arithmetic.

And I have plainly proved, that the roots of cone-wheat have reached mould at two feet distance, after passing through another row, at a foot distance from it, the plants being then but eighteen inches high, and but half grown.

Farmers do not grudge to bestow three or four pounds in the buying and carriage of dung for an acre ; but think themselves undone, if they afford an extraordinary eighteen pennyworth of earth to the wide intervals of an acre ; not considering that earth is not only the best, but also the cheapest, entertainment that can be given to plants. For at five shillings and sixpence rent, the whole earth belonging to each of our rows costs only sixpence, *i. e.* a penny for a foot broad, and six hundred and sixty feet long ; that being the sixty-sixth part of an acre*.

* But the vulgar compute this expense of a foot breadth of ground, not only as of the rent, as they ought, but as an eleventh part of their own usual charges added to the rent. And there is land enough in England, to be had at the rent of five shillings and sixpence the acre, that is very proper for wheat in the hoeing-husbandry.

And if for constant annual wheat crops you make fewer than eleven rows on four-perch breadth, you will always increase the expense of hoeing ; because then two furrows will not hoe one of those intervals, and you will also thereby lessen the crops, but improve the land more. And if you increase that number of rows, you will thereby increase every expense ; for there must be two furrows to hoe a narrow interval, and an increase of the quantity of seed, and the labour in uncovering, weeding, and reaping, and also you will less improve the land, and lessen the crops after the first year.

If the intervals are narrower in deep land, though there might be mould enough in them, yet there would not be room to pulverise it.

If narrower in shallow land, though there were room, yet there would not be mould enough in them to be pulverised.

The horse-hoe well applied, doth supply the use of dung and fallow ; but it cannot supply the use of earth, though it can infinitely increase the vegetable pasture of it by pulverising it, where it is in a reasonable quantity ; yet if the intervals be so narrow that nearly all the earth of them goes to make the partitions raised at top of the ridges, there will be so little to be pulverised that you must return to fallowing, and to the dung cart, and to all the old exorbitant charges*.

Eight acres, part of a ground of twenty acres, drilled with intervals of three feet and a half, brought a good crop ; but the second year, not being hoed, the crop was poor ; and the third crop made that land so foul and turfy, that it was forced to lie for a fallow, there being no way to bring it into

* The objections against these wide intervals are only for saving a penny-worth or two of earth in each row, or a few groatsworth of it in an acre ; by saving of which earth they may lose, in the present and succeeding crops, more pounds.

tilth, without a summer ploughing*, when the rest of the same piece, in wider intervals, being constantly hoed, continued in good tilth, and never failed to yield a good crop, without missing one year.

In another field there is now a sixth crop of wheat, in wide intervals, very promising, though this ground has had no sort of dung to any of these crops, or in several years before them: the last year's crop was the fifth, and was the best of the five, though a yard of the row yielded but eighteen ounces and three quarters, and the third crop yielded twenty ounces weight† of clean wheat in the same spot; but it was because the spot where the twenty grew, was then a little higher than the rest, which in two years became more equal, and the thin land was more deficient in that third crop, than the thick land exceeded the thin in the fifth crop.

In the thick the hoe-plough went deeper, and consequently raised more pasture there; but then it went the shallower in the thin, and when the land became of a more

* This narrowness of the intervals, if the damage of it be rightly computed, would amount to half the inheritance of the land; and was occasioned by the wilfulness of my bailiff, who, drilling it upon the level, ordered the horse to be guided half a yard within the mark, because he fancied the intervals would be too wide, if he followed my directions.

† Wheat before harvest, standing in rows with wide intervals between them, may not seem to the eye to equal a crop of half the bigness dispersed all over the land, when sown in the common manner; and yet there is more deceit in the appearance of those different crops, whilst they are young, and in grass; we should therefore not judge of them then by our imagination, but as we do of the sun and moon nigh the horizon, viz., by our reason.

Imagination often deceives us, by arguments false, or precarious; but reason leads us to demonstration, by weights and measures. Yet this prejudice will vanish at harvest before weighing; for then all those wide intervals that were bare, will be covered with large ears interfering to hide them quite, and make a finer appearance than a sown crop. But it is observed, that the cone-wheat makes the finest show when you look on it lengthways of the rows, both at harvest, and a considerable time before harvest.

equal depth the fifth year, the plough and hoe-plough went deeper: all the piece being taken together; for the crop could be but in proportion to the different pasture, allowing somewhat for the more or less seasonableness of the year.

If it should be demanded from whence the soil can be supplied with vegetable matter, to answer what is carried off by these constant crops of wheat, that the land be not consumed by them, Mr. Bradley, and his correspondent, would give a very ready answer, by saying, that vegetables are nourished by air, and that the earth serves for little else than to keep them fixed and steady; therefore the wheat receiving its augment from the air, could not consume any part of the earth; this would be an easy, good solution, were it possible to be true.

The soil in this our case cannot be supplied in substance but from the atmosphere. The earth which the rain brings can do it alone if it fall in great quantity; for by water it is plain the earth which nourished Helmont's tree was supplied; for the tin cover of the box wherein it stood, prevented the dews from entering.

Dews must add very much to the land thus continually tilled and hoed; for they are more heavily charged with terrestrial matter than rain is, which appears from their forcing a descent through the air, when it is strong enough to buoy up the clouds from falling into rain; and dew, when kept in a vessel long enough to putrify, leaves a greater quantity of black matter at the bottom of the vessel than rain-water does in a vessel of the same bigness, filled with it until putrified.

Dews at land, I suppose, are first exhaled from rivers and moist lands, and from the expirations of vegetables; most of the dew that falls on it is re-exhaled from untilled land; but most of that which falls on well tilled or well hoed land, remains therein unexhaled; so that the untilled ground helps by that means to enrich and augment the tilled, contrary to

that of Virgil : *Nec nulla interea est inarata gratia terræ* : for if an acre be tilled two years together without sowing it will become richer by that tillage, than by lying unploughed four years, which may be easily proved by experience*.

But, then, as to rain, the sea being larger than all the land (and its waters by their motion becoming replete with terrestrial matter), it is not unlikely that more vapour is raised from one acre of sea, than from one hundred acres of land. Hence it is very probable, that islands are continually gaining from the deep, by means of rain, which that vapour (breaking against mountains) produces.

Some have been so curious as to compute the quantity of rain that falls yearly in some places in England, by a contrivance of a vessel to receive it ; and it is found in one of the driest places, far from the sea, to be fourteen inches deep, in the compass of a year ; in some places much more ; viz., at Paris, nineteen inches ; in Lancashire, Mr. Townley found, by a long continued series of observations, that there falls above forty inches of water in a year's time.

Could we as easily compute the true quantity of earth in rain water, as the quantity of water is computed, we might, perhaps, find it to answer the quantity of earth taken off from our hoed soil annually by the wheat.

But if land sown with wheat be not hoed, its surface is soon incrustate, and then much of this water, with its contents, runs off, and returns to the sea, without entering that ground ; and in summer, a great deal of what remains is exhaled by the sun, and raised by the wind, both in summer and winter.

Some there are who think it a fatal objection, that the more an interval is hoed, the more weeds will grow in it ;

* *Non igitur Fatigatione, quemadmodum plurimi crediderunt, Nec Senio, sed nostra scilicet Inertia minus benigne nobis arva Respondent.* Col. Lib. 11, cap. 1.

and that the hoe can produce, or (as they say) breed in it as many weeds in one summer, as would have come thereon in ten years by the old husbandry. But by this objection they only maintain, that the hoe can destroy as many weeds in one summer, as the old husbandry can in ten years.

And they might add, that since all weeds that grow where the hoe comes, are killed before they seed, and that few of those which grow in the old husbandry are killed* before their seed be ripe and shed; these objectors will be forced to allow that our husbandry will lessen a stock of weeds more in one summer than theirs can do to the world's end; unless they believe the equivocal generation of weeds, than which opinion nothing can be more absurd.

Some object against my method of weighing a yard or a perch in length of a row, saying, this does not determine the produce of a whole field.

I did not weigh this yard as different from the other yards round about it, for I had much difficulty to determine which row I should choose it in; when I was going to cut it in one row, it still seemed that another was better, and I question whether I did choose the best at last.

Note, Whereas I often mention the wheat of this field to be without dung or fallow, it must be understood of that part of the field wherein my weighings and other trials were made; because there was a small part once fallowed eight or nine years ago; and a little dung laid on another part about the last Michaelmas, after the crop of oats was taken off. But this being a year in which dung is observed to have little or no effect on sown wheat, (my dung being weak and laid thin,)

* Weeds cannot be killed before they grow, but will lie dormant, as they do in our partitions, and in their sown land; and while the seeds are in the ground, they are always ready to grow at the first opportunity; and will certainly break out at one time or other; so that preventing their coming, is only like healing up a wound before it be cured.

it is the same here, for those rows which are in the dunged part can hardly be distinguished from the rest of the rows which had not been dunged : and yet the ends of the rows which were cleansed of weeds are very distinguishable by the colour of the wheat, though some are the third, and some the fourth crop since the difference was made ; and the whole rows managed alike every year from that time to this ; so that here unexhaustion is more effectual than dung. This is certain, that neither dung nor fallow has been near the part wherein my experiments were made.

I answer, that they judge right, if the produce of the whole field be not of equal goodness ; but if it be not, it must be because one part of the field is richer, or differently managed from the other part : for the same causes that produce twenty ounces of clean wheat upon one yard, must produce the same quantity upon every yard of a million of acres.

When the crop of half a field is spoiled by sheep, not hoed at all, or improperly, it would be ridiculous to compute the whole field together for an experiment. We might, indeed, weigh the poorest, to prove the difference of the one from the other, to try (as they sometimes seem to do) how poor a crop we can raise ; but my design was to try how good a crop I could raise with a tenth part of the common expense.

And I have often weighed the produce of the same quantity of ground* of all sorts of sown wheat, both the best and the worst, but never have found any of the sown equal to the best of my drilled ; indeed we have none of the richest land†

* I allow two square yards of their crops to one yard in length of my triple row.

† I am sorry that this farm, whereon I have only practised horse-hoeing, being situate upon a hill that consists of chalk on one side, and heath-ground on the other, has been usually noted for the poorest and shallowest soil in the neighbourhood.

In contradiction to this description, Equivocus, in p. 31 of his Essay for July, describes it as follows : viz., “ We know the author’s farm, called

in our country within my reach, that being not above one mile.

As a yard in length of my triple row of the third suc-

“ Prosperous, is a rich soil, and lies on a flat, which retains moisture more than up-land declining ground (especially sandy or gravelly) will.”

Which of these two opposite repugnant descriptions is true cannot be difficult to determine.

As to its lying on a flat contrary to a hill, it is both known and seen to be one of the highest farms in all that part of the county of Berks where it lies ; it may be seen at ten or twelve miles distance, and was a more remarkable eminence before the trees were blown down by that memorable storm in the year 1703.

The bulk of the land belonging to this farm is, on the south side, for near a mile in length, always called Bitham Hills, and are, for the most part, declining grounds, a sort of *graciles Clivi*, being all on a chalk : in dry weather the whole staple looks of a white colour, it is full of small flints, and smaller chalk-stones : below these hills is a bottom, where are some grounds upon a chalk also, but had not then been used in hoeing, having lain with St.-Foin thirteen or fourteen years. On the west side all the land is called East Hills, being on the east of the farms to which they all formerly belonged. On the north-west side is a high field, called Cook's Hill, and is the only field of my farm that is not upon a chalk ; it is a very wet spewy soil of very little value, until I made it dry by ploughing across the descent of the hill. Every body knows that chalk is not apt to retain moisture ; and as to the richness of the soil of my farm, if Equivocus could make that out to be true, I could easily forgive all the other falsities of his description, though it is scarce possible that any thing can be more false.

This soil is all too light and too shallow to produce a tolerable crop of beans.

This farm was made out of the skirts of others ; great part of the land was formerly a sheep down ; and whilst the whole was kept in the Virgilian management (usual for such land) it had the full reputation of poverty. The highest part of it used to be sown (as I have been well informed) with oats once in two or three years upon the back, and if the summer proved dry, the crop was not worth the expense of that once ploughing. The generality of farmers were then of opinion, that if this should be thoroughly tilled and pulverised, it would become so light that the wind would blow the staple away ; but the contrary happened, for it being ploughed five times instead of once, it produced good barley and other corn, and never has returned to its former degree of lightness since, and this was above fifty years ago. And now tillage and foreign grasses are come into fashion, enclosed lands, which do not rot sheep, (as not one foot of mine is wet enough or rich enough to do,) are become of greater value than formerly. And besides they allow that my farm is one-third better for a te-

cessive crop of wheat, without dung or fallow, produced twenty ounces of wheat ; which, allowing six feet to the ridge, is about six quarters* to an acre ; and allowing seven inches to each partition, and two inches on each outside, is, in all, eighteen inches of ground to each triple row, and but just one-fourth part of the ridge. Now if, in the old husbandry, the crop was as good all over the ground, as it was in these eighteen inches of the triple row, they must have twenty-four quarters to an acre ; but let them dung whilst they can, they will scarce raise twenty-four gallons of wheat the third year, on an acre of land of equal goodness ; and let them leave out the dung, and add no more tillage in lieu of it, and I believe they will not expect three quarters to an acre, in all the three years put together.

The mean price of wheat, between dear and cheap, is reckoned five shillings a bushel;† and therefore an acre

nant than when I took it in hand, and yet I should be glad to let it for half the rent that rich land is let for.

Should Equivocus tell a person who never was at London, that the monument stands in Smithfield, or that London-bridge is upon Holborn-hill, it would not be more notoriously false than his description of my farm is.

And that no part of the true description of that odious crime (the plain term for which ought not to be given by or to an Englishman, except to one as vile as Equivocus) might be wanting ; he, for the collective body of his Society, pronounces in the plural number, We know, &c. So that it is not ignorantly, but wilfully committed, by endeavouring to impose upon the world, for a truth, what they know to be false, with intent to deceive.

He seems to have written his false description of my farm for no other end than to accuse me of that very crime of which he himself is, in this relation of his, indisputably guilty ; for if the nature and situation of my land had been as he says, it would have made nothing for his purpose in any other respect.

That Society, by publishing this and many other notorious falsities, seems fond of being publicly known to be infamous authors of no veracity, and not to be credited by any body who is not willing to be deceived ; but pity it is their particular members should lose their merited renown, for want of a proper list of names and additions.

* Eight bushels make a quarter.

† It is commonly said, that a farmer cannot thrive, who, for want of

that would produce every year, without any expense, eight bushels, would be thought an extraordinary profitable acre; but yet a drilled acre, that produces sixteen bushels of wheat, with the expense of ten or fifteen shillings, is above a third part more profitable.

I do not know that I ever had an acre yet, that was tolerably well managed in this manner, but what produced much more.

That which is ill done, I reckon as not done : want of skill and want of will are much the same thing. My agricul-

money is obliged to sell his wheat under five shillings a bushel ; but if he will sell it dear, he must keep it when it is cheap : and his way of keeping it is in the straw, using his best contrivances to preserve it from the mice.

The most secure way of keeping a great quantity of wheat, that ever I heard of, is by drying it. When I lived in Oxfordshire, one of my nearest neighbours was very expert in this, having practised it for great part of his life. When wheat was under three shillings a bushel, he bought in the markets as much of the middle sort of wheat as his money would reach to purchase. He has often told me, that his method was to dry it upon a hair-cloth in a malt-kiln, with no other fuel than clean wheat-straw, never suffering it to have any stronger heat than that of the sun. The longest time he ever let it remain in this heat was twelve hours, and the shortest time about four hours ; the damper the wheat was, and the longer intended to be kept, the more drying it requires ; but how to distinguish nicely the degrees of dampness, and the number of hours proper for its continuance upon the kiln, he said was an art impossible to be learned by any other means than by practice. About three or four and twenty years ago, wheat being at twelve shillings a bushel, he had in his granaries, as I was informed, five thousand quarters of dried wheat, none of which cost him above three shillings a bushel.

This dried wheat was esteemed, by the London bakers, to work better than any new wheat that the market afforded. His speculation which put him upon this project was, that it was only the superfluous moisture of the grain that caused its corruption, and made it liable to be eaten by the wevil ; and that when this moisture was dried out, it might be kept sweet and good for many years ; and that the effect of all heat of the same degree was the same, whether of the straw or of the sun.

As a proof, he would show that every grain of his wheat would grow after being kept seven years.

He was a most sincere, honest yeoman, who, from a small substance he began with, left behind him about forty thousand pounds, the greatest part whereof was acquired by this drying method.

ture having been carried on by common day-labourers without anybody to inspect them (except when my diseases suffered me to attend them, which for several years last past has been very seldom), cannot be expected to be all well managed, for though they can do it well when they please, yet their will being above control, I must be content with their doing some tolerably well every year.

But perhaps it may be asked why I do not carry on my new husbandry by house servants ? This indeed might be a proper question in other countries, but is not here ; for husbandry servants of all sorts have now attained to such a thorough knowledge of their own arbitrary power given them over their masters by our statutes, (which are new laws,) and the judgments thereupon, that I would not keep ploughmen in my house, though it were to get a new farm yearly ; especially since the famous judgment given publicly by some country magistrates, that encourages the most disorderly servants against fear of punishment for the most enormous crimes they can commit against their masters (those strictly capital only excepted, which are triable before the king's judges and a jury). It is not proper for me to report this case, in regard to the respect I bear to all magistrates, and to those four (which were the number) in particular. Nor will I believe there was either party or prejudice in it, whatever may have been by many of the hearers on that trial insinuated.

For my own part, I always chose to suffer under my labourers, and house-servants too, when I formerly kept them, rather than to suffer more by complaining, as I apprehended my neighbours generally did ; and therefore no magistrate ever had any trouble upon my account.

Besides, my diseases now prevent my complaining, though I should have hopes of redress, and will not permit me to travel so far as to the nearest magistrate ; and he who sends

one servant to complain of another, is likely to make but little of his cause : or what adequate satisfaction can be had for the greatest damage done to the master by the servant, who takes care, by spending all his exorbitant wages, as most of them do, not to be worth a farthing?

There are also other objections, peculiar to my case, against house-servants. One is, that they have made it a custom to leave their service whenever they please, which is commonly at spring of the year, when they are by farmers reckoned not to have earned more than their diet ; for then they must have half a year's wages from Michaelmas, and afterwards they can, in another service, have almost a whole year's wages for the remaining summer half year ; if you will not consent to let them go, and comply with such terms, they will make them much worse by spoiling or killing your cattle, or by other private devices, in which they are better skilled than in their proper business.

But this is only a misfortune common to all English agriculture ; but what is peculiar to my scheme is, that when servants go away, I must be continually teaching new ones, when I can find them, both which my confinement and want of health make difficult.

This objection is not quite so strong against day labourers, because they are paid by the week, and being settled, married men, have not so much choice of services as the single, unsettled have.

Upon these accounts the day-men do not impose so hard terms as the other. When I have taught them my scheme, they will continue to work for me as long as my service is more beneficial to them than any other they can get ; and as long as I will forbear to find much fault with what they do, or at least forbear to speak to them of their faults otherwise than in a very humble, persuasive manner ; with these terms I would gladly comply, if it were only to purchase that peace

and quiet which are necessary to my infirmities, and incompatible with keeping ploughmen in my house.

This precarious condition we are in as to hands, under the present regulation, is very discouraging to every new scheme that requires labour ; but the thing that is most detrimental to perpetual crops of wheat, is the deceit and idleness of the weeders, that are necessary to cleanse the partitions and rows from weeds, by hoes, or hands, or both, especially after they have been a year or two neglected, their shattered seed, in that case, overstocking the ground. These weeders are the same sort of people that Mr. Duck describes as hay-makers, their tongues are much nimbler than their hands ; and unless the owner, or some person who faithfully represents him, and is hard to be found, works constantly amongst them, they will get their heads together half-a-dozen in a cluster, regarding their prattle more than the weeds ; great part of their time they spend in play, except a few of them who bring their own work with them, some their sewing, some their knitting, and these must be paid for doing their own work upon my land. This wrong I have seen done both to myself and my neighbours ; and it has put me upon endeavouring to find a way of disappointing the weeders, viz., by planting wheat sometimes upon a fallow without dung for one crop only ; and this is done in the following manner :— After a crop of barley sown upon the level, or broad cast, had immediately succeeded several successive horse-hoed crops of wheat, this barley stubble was fallowed in the spring, tilled in the summer, and after St. Michael ploughed up into ridges of different sizes, none under four feet, nor any above five feet ; then drilled with white cone-wheat in triple rows, by my usual wheat drill, having its marking-wheels set nearer together according to the different sizes of the ridges. The partitions not being infested with weeds, no weeders were employed thereon, but the intervals were horse-hoed. The crop of wheat was good, it appeared like a sown crop in

thickness at top before it was reaped, except that the ears were much larger, and there were few under ears. It was indeed on some of my best land, but has had no dung or manure since the year 1720, and this crop was in the year 1734.

By this means the weeders being convinced that it was possible for me to make a shift to go on with my hoeing scheme without employing them, they are brought now to better terms, viz., to hoe the two partitions of the triple row, and also all the earth that is left by the hoe-plough on each side of the row, and to cleanse all the row from weeds; for all this work they agree for the price of a penny a score, *i. e.* twenty perch in the length of a row, which in the six-foot ridges amounts to one shilling and ten pence per acre. At this price they earn almost double the common wages; and yet, if they work by the day, it will cost me double of this price to have it worse done; so great a difference there is between their working for me, and working for themselves. The weeders generally are women and boys, and even these sometimes earn men's wages, so that I have plenty of them, and choice; for they make an interest to be employed. It is only necessary for me to take care that they do their work well, and to oblige them in the bargain to amend what they do amiss; and for that end, the rows that each person or company undertake are separately known. I give them the same price for oats and barley as for wheat, and the same for double rows as for triple; because as the former are less troublesome they hoe them the deeper.

They use for this work hoes of four inches' breadth, very thin and well steeled; their thinness keeps them from wearing to a thick edge, and prevents the necessity of often grinding them. Such hoes are in use with some gardeners near London. They need not be afraid of drawing these little hoes across the rows of young wheat to take out the few weeds that come therein at the early hoeing; for whilst the wheat-

plants are small it may be an advantage to cut out some of the weakest, as they do of turnips ; for I perceive there are oftener too many plants than too few. But the thing that causes the greatest trouble in cleansing the rows, is when the seed is foul, (*i. e.* full of seeds of weeds,) therefore I cleanse my seed-wheat by drawing it on a cloth on a table, which makes it perfectly clean.

This hand-hoeing should be performed about the end of March or beginning of April, before the wheat is spindled (*i. e.* run up to stalks), and if the weather be dry enough, you may go lengthways of the ridges with a very light roller to break the clods of the partitions, whereby the hoe will work the better.

If there should afterwards more weeds come up, they must not be suffered to ripen ; and then the soil will be every year freer from weeds.

This hand-hoeing of the rows should be done at the proper time, though it happen, by late planting, that the horse-hoe has not gone before it ; for it may be, that the weather has kept out the horse-hoe ; and the earth may not be dry deep enough in the intervals for the hoe-plough, but deep enough in the partitions for the hand-hoe.

And the expense of this hand-work on the rows would be well answered, though there should not be one weed in them ; and so it would be, if a second hand-hoeing were bestowed on the partitions of every crop of wheat not suspected of being too luxuriant.

If after the last horse-hoeing there should be occasion for another hoeing of the intervals, where the narrowness of them, and the leaning of tall wheat make it difficult or dangerous to be performed by the hoe-plough, a slight shallow hoeing may be performed therein by the hand-hoe with ease and safety, at a very small expense, which would be more than doubly repaid in the following crops.

CHAPTER XII.

OF SMUTTINESS.

SMUTTINESS is when the grains of wheat, instead of flour, are full of a black, stinking powder; it is a disease of wheat, which I do not know is usual any where but in cold northern countries; for if it had been common in Greece or Italy, there would probably have been some word to express it by in those languages, as well as there is for the blight.

I take it to be caused by cold wet summers, and I was confirmed in this, by several plants of wheat, taken up when they were in grass in the spring, and placed in troughs in my chamber window, with some of the roots in water, in exactly the same manner as the mints, marked *H H*, in Chapter of Roots. These wheat-plants sent up several ears each; but at harvest, every grain was smutty; and I observed, none of the ears ever sent out any blossom; this smuttiness could not be from any moisture that descended upon it, but from the earth, which was always kept very moist, as in the aforesaid mint experiment. The wheat-plants in the field, from whence these were taken, brought very few smutty grains, but brought much larger ears than these.

Whatsoever the cause* be, there are but two remedies proposed; and those are brining and change of seeds.

Brining of wheat, to cure or prevent smuttiness (as I have been credibly informed) was accidentally discovered about seventy years ago, in the following manner; viz., a ship-

* The largest grained, plump, fat wheat, is more liable to smuttiness than small grained, thin wheat.

load of wheat was sunk near Bristol in autumn, and afterwards at ebbs all taken up, after it had been soaked in seawater; but it being unfit for making of bread, a farmer sowed some of it in a field, and when it was found to grow very well, the whole cargo was bought at a low price by many farmers, and all of it sown in different places. At the following harvest, all the wheat in England happened to be smutty, except the produce of this brined seed, and that was all clean from smuttiness. This accident has been sufficient to justify the practice of brining ever since, in all the adjacent parts, and in most places in England.

I knew two farmers, whose farms lay intermixed; they bought the same seed together, from a very good change of land, and parted every load between them in the field. The oldest farmer believed brining to be but a fancy, and sowed his seed unbrined; the other brined all his part of seed, and had not a smutty ear in his crop; but the old farmer's crop was very smutty.

Wheat for drilling must have no other brine than what is made of pure salt; for if there be any brine of meat amongst it, the grease will not suffer the wheat to be dry enough to be drilled.

Urine also makes the wheat so greasy, that it will not be dry time enough to be drilled.

If seed-wheat be soaked in urine, it will not grow; or if only sprinkled with it, it will most of it die, unless planted presently.

The most expeditious way of brining wheat for the drill is, to make a very strong brine; and when the wheat is laid on a heap, sprinkle or lave it therewith; then turn it with a shovel, and lave on more brine, turn it again with a shovel, until by many repetitions of this, the wheat be all equally wet. Next sift on quicklime through a sieve, turn the wheat with a shovel, and sift on more lime, repeat this sifting and

turning many times, which will make it dry enough to be drilled immediately; and this has been found sufficient to preserve uninfected wheat from the smut in a bad year, the seed being changed.

To dry it, we use quicklime, (that is, unslaked,) which beaten to powder, and sifted thereon, confines the brine to the surfaces of the grains, and suffers none of it to be exhaled by the air. But when lime has been long slaked, and is grown weak, it is unfit for this purpose.

But if this does not afford powder enough, the pieces must be slaked immediately before using; for if the lime lie long after it is slaked, (especially that made of chalk,) it will become weak and lose most of its drying quality.

Some farmers used only to boil the strongest quicklime in water, with which instead of brine they sprinkled their wheat, affirming it to be as effectual as that for preventing the smut; but this not being within the compass of my own experience, I am doubtful of it; yet I wish it may be found effectual, because it would save trouble to the sower, and more to the driller.

Smutty seed-wheat through brined, will produce a smutty crop, unless the year prove very favourable.

For it is to be known, that favourable years will cure the smut, as unkind ones will cause it: else before brining was used, and the bad years had caused all the wheat in England to be smutty, they must have brought their seed from foreign countries, or never have had any clean wheat; therefore it is certain, that kind years will cure the smut. It is therefore to prevent the injury of a bad year, that we plant clean seed and well brined.

But of the two remedies against smuttiness, a proper change of seed some think the most certain.

A very worthy gentleman assures me, that since he has found out a place that affords a change of seed proper to his

land, which is for these ten years past, he never had a smutty ear in any of his crops, (and he never brines nor limes it) though all other wheat have been often smutty throughout his neighbourhood every wet year, though brined and limed; he says the person who furnishes him with this seed, is very curious in changing his seed also every year.

This gives a suspicion, that our drowned wheat at Bristol might possibly be foreign, and then might not have been smutty the next year, though it had not been soaked in the sea-water.

The wheat sown by the two farmers afore-mentioned might be from a good change of land, but the seed not changed the precedent year, and then it might be no more infected, than what the brine and lime did cure.

To know what changes are best to prevent smuttiness of wheat, we must consult the most experienced; and they tell us, that the strong clay land is best to be sent to for seed wheat, whatever sort of land it be to be sowed upon; a white clay is a good change for a red clay, and a red for a white. That from any strong land is better than from a light land, and the old rhyme is, that sand is a change for no land. But from whatever land the seed be taken, if it was not changed the preceding year, it may possibly be infected, and then there may be danger, though we have it immediately from never so proper a soil.

The strongest objection that has been yet made against constant annual crops of wheat is, that those grains of the precedent crop which happen to shed, and grow in the following crop, will be in danger of smuttiness, for want of changing those individual seeds.

All I can say in answer is, that during these five years which is all the time I have had these annual crops, this objected inconvenience never has happened to me, even when a precedent crop has been smutty.

The reason I take to be, that a crop very early planted is not so apt to be smutty; and if it be not planted early, the grains that are shed grow, and are killed before, or at the time of planting the next crop. This saves a crop following smutty one, (which is always occasioned by bad seed, or bad ordering,) and when the former crop was planted with good seed well ordered, the shattered grains of that may produce clean wheat the second year; and it is very unlikely, that any breed of these grains should remain to grow in the crop the third year.

CHAPTER XIII.

OF BLIGHT.

THE ancients did not take notice, that there were several sorts of the blight; neither did they inquire after their causes, which unless they knew, it was not likely they should find any effectual remedy to prevent. They called it in general by the name of Rubigo, for the likeness the blighted straws and leaves had to rusty iron in colour.

They thought it came all from heaven, since they were ignorant of the natural causes, viz. want of nourishment in the earth, &c.

Virgil was very sincere, where he had no hopes of any great gain by flattery; and tells the husbandman in plain terms, that if his corn be eaten with the blight, he can give him no better advice, than to comfort his hunger by eating of acorns; but has no recipe to prescribe by way of prevention.

Palladius, Lib. I. Tit. 35. recites many receipts against the blight, and other injuries, which were thought to come from above. The chief efficacy of them seems to consist in secret contrivances, by sympathies and antipathies, to fright the clouds. And when prayers and sacrifices would not prevail with the *Cælicolæ*, the ancients, it seems, proceeded to threatenings. *Cruentæ secures contra cælum minaciter levantur*. They brandished bloody axes against the gods, as a summons to surrender, or else to expect no quarter. But unless these peasants had been better engineers than the giants, in besieging heaven, their menaces must be vain.

They acted like some modern zealots, who take much the same course with their saints, as these heathens did with their gods: viz. when they are weary of praying in vain to their images, that are so idle or obstinate, as not to procure what their votaries have a mind to, they think to bring them into better manners by correction; and from prayers fall to whipping their saints *in effigie*. Yet it is to be feared, none of this bigotry will cure the blight.

Palladius thought also, with others of the ancients, that heaven was to be frightened with red-cloth, with the feathers or heart of an owl, and a multitude of such ridiculous scare-crows, from spoiling the fruits of the fields and gardens.

The ancients having no rational principles or theory of agriculture, placed their chief confidence in magical charms and enchantments: which he, who has the curiosity and patience to read, may find in the title afore-mentioned, in Cato, in Varro, (and even Columella is as fulsome as any of them,) all written in very fine language; which is most, if not all of the erudition that can be acquired from the Greek and Latin writers, of field-husbandry, in verse and in prose.

Wheat is blighted at two seasons; first, when in the blossom, and then its generation is prevented, and many of the husks are empty in the ear, the grains not being impregnated.

Secondly, wheat is blighted when the grains are brought to the time of their maturity, but are light and of little value for making of bread; because they are not well-filled with flour.

The first cannot happen in England by the frost, because the winters do not suffer it to grow so much, as to come into blossom before the month of June; but it is long continual rains that rot or chill the blossoms, and prevent their fertility. Yet this is what seldom happens to any great degree, and we are happy that it does not, since modern credulity is not strong enough to rely on the remedies prescribed by the

ancients; and we know of no other which are effectual against this sort of blight. Wheat that grows in open fields has some advantage from the wind, that dislodges the water sooner from the ears, than it can do in sheltry places; and Lammas-wheat does not hold the drops of rain so long as the bearded (or cone) wheat, which received very great damage by this sort of blight in the year 1725; the like never having been heard of before, I hope it may never happen again.

The second sort of blight, viz. from light ears, is that which is most frequent and more general: this brings the greatest scarcity of wheat. The cause is plainly want of nourishment to perfect the grain, by whatever means that want is occasioned.

Several accidents kill the plants, or injure their health, and then the grains are not filled; as lightning, the effects whereof may be observed by the blackish spots and patches in fields of wheat, especially in such years as have more of it than usual. Against this there is no defence; for the ancients tell you the giants found that even mountains were not thunder-proof.

And yet Columella, Lib. X. p. 353, says,

*Utque Jovis magni prohiberet fulmina Tarchon,
Sæpe suas Sedes percinxit vitibus albis.*

Again Columella.

----- Salutis
*Ipsa novas artes varia experientia rerum,
 Et labor ostendit miseris, ususque magister
 Tradidit agricolis, ventos sedere faventes,
 Et tempestatem Thuscis advertere sacris.
 Hinc mala rubigo virideisne torreat herbas,
 Sanguine lactentis catuli placatur, et extis.*

What credit can be given to the fine words of these ancients who join altogether in verse and in prose to impose

upon posterity, even in matters of fact; and, by the most elegant expressions, compose a theory of Agriculture without reason or truth? They were most accomplished masters of the art of cheating themselves and us with sound instead of sense.

It is, I suppose, on account of this paragraph, that Equivocus exclaims against me for having wronged the ancients. Perhaps he may give credit to that pretended invention of Tarchon's; and so to the following famous remedy prescribed in verse and prose for the relief and cure of plants, which is the same that is in prose affirmed will destroy them.

At si nulla valet medicina repellere pestem,
Dardaniæ veniant artes, nudataque plantas
Fæmina, quæ justis tum demum operata juventæ
Legibus, obscæno manat pudibunda cruore,
Sed resoluta sinus, resoluto mæsta capillo,
Ter circum areolas, et sepem ducitur horti;
Quæ cum lustravit gradiens (mirabile visu!)
Non aliter quam decussa pluit arbore nimbus
Vel terretis mali, vel tectæ cortice glandis,
Volvitur ad terram distorto corpore campe.

COLUMELLA, Lib. x. p. 354.

Atqui mulierem menstruantem, nusquam cinctam, solutis capillis, nudis pedibus contra. Erucas, et cætera, hortum faciunt circumire.—PALLAD. in Lib. i. p. 28.

Compare the two preceding paragraphs with the two following.

Rutæ frutex plurimis annis permanet innoxius, nisi si mulier quæ in menstruis est contingeret eum, et ob hoc exaruerit.

COLUMELLA, p. 395.

Mulieris fere contactu languescunt incrementa virentium. Si vero etiam in menstruis fuerit, visu quoque suo novos fætus necabit.—COLUMELLA, p. 398.

I think I have quoted enough from these ancient pious heathen worthies, to show their truth in those times when contradictions were true.

The next is an ingenious remedy against a storm.

Non nulli ubi instare malum viderint, oblato speculo imaginem nubis accipiunt, et hoc remedio nubem (seu ut sibi objecta displiceat, seu tanquam geminata alteri cedat) avertunt.—PALLAD. p. 31.

Then follows the great virtue of a mare's or an ass's skull, the theory of which notion, though it pass unobserved by most of the vulgar, may afford matter of curious speculation to the learned, especially such as Equivocus.

Equæ calvaria, sed non virginis, intra hortum ponenda est, vel etiam asinæ, creduntur enim, suæ præsentia, fæcundare quæ spectant.—Ibid.

The ordinary vulgar are not so inquisitive after the causes of such effects; but if they had read the ancient heathen worthies, they might find the extraordinary fecundity of mares (and I do not question but there was, in those times, the same in asses,) that did at certain times conceive without the assistance of the male: indeed, Varro tells us it is both true and incredible.

In fætura res incredibilis est, sed est vera, quod quædam e vento concipiunt certo tempore equæ. Sed ex his equis, qui nati pulli, non plus triennium vivunt.—VARR. Lib. ii. Cap. I.

If this relation of the pious worthy was as false as it is incredible, I do not see what ground the ancients had to make trial of the above receipt, before they put it into practice, so far as to believe it themselves; and Equivocus doth not pretend to excuse, by a *licentia poetica*, those writers in prose, for their flights in propagating falsehoods to the world, which they did not seriously believe themselves.

Was it then the great fruitfulness of the mare (for she must not be a virgin) that endued her bare skull with the power of imparting her fecundity to plants in that manner?

I dare say none of our moderns (except vulgar) have credulity enough to believe this relation true, or that the receipt was ever put in practice; and then where is the cre-

dit of such pious worthies? But Equivocus may with a less degree of impossibility (if there are degrees of impossibilities) believe, that females propagate their kinds without males, than, with those ancients, believe equivocal generation by which animals and plants are propagated without male or female.

The next specimen I shall give of ancient doctrine is from Columella, p. 395.

Cujus (mentæ) si forte semina defecerunt, licet de novalibus sylvestre mentastrum colligere, atque ita inversis cacuminibus disponere, qua res feritatem detrahit, atque edomitam reddit.

These mints, though there is some agreement in their names, are of two very different species; and therefore modern naturalists can have no faith in such a whimsical metamorphosis, the falsity of which may be easily shown by experiment to confute what Equivocus calls 1700 years' experience.

For confirmation of what Equivocus from Varro directs about the besmearing of sheep, hear whence that *Patrius mos* was derived.

Ego ista etiam, inquit agratius, non solum in ovibus tondendis, sed in meo Capillo a patre acceptum servo, si decrescente Luna tondens calvus fiam.—VARR. Lib. i. Cap. xxxvii.

But the world is now grown so incredulous, that they cannot believe that a man will become bald by being shaved at the wrong time of the Moon, without more experience than has been made of it for these 1700 years past; though they have the word of this honoured worthy for the truth of it.

If all these phantasies delivered down to us from the ancients, be looked on as mere fables without any foundation of reason or truth, why should we acquiesce in following that pretended maxim, which, though it has deceived some part of the world a great while, doth, when brought to the test of

experiment prove as fallacious as the rest? Take it from Columella as follows :

Item *graciles clivi* non sunt æstate arandi, sed circa Septembris Calendas: quoniam si ante hoc tempus proscinditur, effæta, et sine succo humus æstivo sole peruritur, nullasque virium reliquias habet.—COLUM. p. 48.

The experience of 1700 years no more proves this practice to be right, than the long experience of cattle drawing by their tails proved that practice right, before drawing by traces was by experiment proved to be better: for nothing can be depended on as experience, which has not been tried by experiment.

Columella himself proves the contrary to this his maxim, when he affirms (and with great truth) that the more the vineyards are pulverised, the more they will produce.—COLUMELLA, p. 578.

And vineyards are generally on light land, and very many on *graciles clivi* too steep for the plough, yet if the pulverisation of these poor vineyards be neglected, they will produce nothing, and in a few years die; which proves, that the neglect of pulverisation starves the vines, and that the use of it enriches that soil, and doth not make it barren; for if it did, it would have a contrary effect on the vines. And what Virgil directs in all vineyards without exception, viz.

- - - - - Glebaque versis
Æternum frangenda bidentibus—

would ruin most of the vineyards of Italy and France, if pulverisation were destructive to light land; for the ancients did not use to allow dung to the vineyards, as appears from Cato de Re Rust, fol. 17. *a.* and from Columella, p. 73. where it is said,

Stercus vitibus non ingerendum, quod saporem vini corrumpet.

This most elegant author, Columella, is certainly much in

the wrong, when he directs this late ploughed land to be presently ploughed again, *aratur et subinde iteratur*.

Twice ploughing for wheat is worse than but once; for the second ploughing makes that ground more hollow, causes more seeds of annual weeds to grow, and kills fewer of the perennial weeds that lived on it whilst it was fallow, than the first ploughing alone would do. The second is a sort of unploughing, for it turns the turf the same side uppermost as before it was ploughed at all.

Such twice ploughing for wheat, I think, is the very worst sort of insufficient tillage.

But to bring this heathen doctrine to the test, let part of the same land before sowing be tilled for two summers, and the winter that is betwixt them; ploughing it often enough to pulverise it, and to prevent exhaustion by vegetables; which experiment will show, whether the summer sun doth strengthen or weaken, enrich or impoverish the soil of those *clivi*, more or less, by that mature pulverisation, than by the two late ploughings directed by Columella.

I propose these frequent ploughings only by way of experiment; and not that I conclude from thence, that every sort of such thin barren land will answer the expense of so much tillage; for though no land may be strictly barren, yet some is so near being so, that it is unprofitable when kept in arable. I have observed, that the renting price of rich arable land, and poor, is not generally in proportion to their respective values; considering their different goodness, the best land is the best bargain.

Words without reason or truth are sound instead of sense: see the following from the wise and grave Cato, the senior of the four worthies.

Luxum, si quod est, hac cantione sanum fiet; arundinem prende tibi viridem p. 4. aut 5 longam. Mediam diffinde, et duo homines teneant ad coxendices. Incipe cantare in alio, S. F. motas vata

daries dardaries astataries dissunapiter, usque dum coeant : ferrum insuper jactato, ubi coierint, et altera alteram titigerit, id manu prende et dextra sinistra præcide. Ad luxum aut ad fracturam alliga, sanum fiet, et tamen quotidie cantato in alio, S. F. vel luxato. Vel hoc modo, huat hanat huat, ista pista sista, domiabo dan-naustra, & luxato. Vel hoc modo, huat huat huat ista sis tar sis ardannabon dunnaustra.—Luxum ut excantes, M. CATO de Re Rust. fol. 41. b.

An English translation of these Roman authors, being promised to appear speedily, I need at present quote no more of their theory or practice, in justification of the opinion I have given of them.

If what they wrote so long ago was then false, it cannot be true now ; and we owe no veneration to falsehood for the sake of its antiquity, or of the fine language in which it is written ; though both these advantages have a powerful influence on vulgar minds, especially such as have more respect for sound than for sense and truth.

But although by a natural sympathy he has with falsehood, Equivocus may have an attachment to ancient errors, and to defend what is wrong in these Roman authors ; yet it is possible it may be partly owing to his ignorance, that he perverts what is right (if any thing besides a fine style be right) in them. He is so ignorant of the difference there is between the climate of England, and that of Italy, as in p. 143. of his Essay for June, to direct from Columella the sowing of winter vetches for feeding green on the ground by cattle in the winter, which has not heat enough to bring them to a substance for feeding of the fifth part of the value of the seed sown, nor of the twentieth part, were we to sow so much on an acre, as he directs, viz., six bushels. The climate of Naples is indeed so warm, that such forage will grow to be a large crop in winter. Equivocus seems to be also partly led into this shameful blunder by his ignorance in the etymology of the name, in which he pretends to be so well learned. They are called winter

vetches, because they are just able to endure the cold without dying, and when winter is over, they grow and become a crop. But Equivocus thinks they have their name on account of being a crop in the winter. He is as ignorant too in the difference of English and Italian measures of land and corn, which makes him direct the sowing three or four times more seed than is necessary and usual to sow; and it is certain, that they sow less seed of vetches and winter corn in Columella's country than here, because there none is killed by the cold. Equivocus says, in p. 136 of his Essay for May, that "as the situation and soil of those countries are very different from that of Great Britain, few of their rules will be here mentioned." But how he contradicts himself in this particular, see his preface to September, not paged; where to show the world what an ignorant pretender he is, he most ridiculously reproaches all our English modern authors for not recommending to our countrymen those rules and precepts of ancient Romans, which every man of reason, acquainted with the world, must know are impossible to be practised in our climate.

He prefers the knowledge of the ancients in their choice of soils and their manner of working and ploughing them.

From the first he takes the great discovery, that strong land is better for corn than light hollow land; and gives this reason for it: "For whatever the husbandmen of any age may think, corn does not do so well on grounds, which are naturally hollow or light, as they do on those which are made so by ploughing: because in one, the earth naturally closes in again round about the roots, and keeps the moisture from being exhaled too fast: whereas ground which is hollow or light, detains it not at all." Those are the poorest of all the reasons that can be given to prove that strong land is better than light; for it is from the misfortune of subsidging too soon, and retaining moisture too long, that

our strongest lands in wet years fail of their crops, when our light lands produce good ones.

But the modern reasons are these, viz., a cubic inch of strong land, being heavier, is better in quantity, and has more earth in it than a cubic inch of light land, as a loaf without leaven has more bread in it than a leavened loaf of equal dimensions; for it is the weight that determines the true quantity of a soil and of bread.

Also strong land has generally a deeper staple, whereby it exceeds light land in dimensions too; a superficial foot of twelve inches' depth having twice as many cubic inches in it, as a superficial foot of but six inches depth.

And it may be a question, whether this advantage of quantity both in weight and dimensions is not greater than the advantage strong land has over the British light land, on account of their different qualities; for as the specific lightness of light land proceeds from some peculiar natural leaven, which puffs up and distends its pores, its hollowness continues only whilst the earth is in its natural state; and upon a perfect artificial pulverisation, the hollowness and lightness cease; for if you take a pound of strong and a pound of light earth, and reduce them to a very fine (and almost impalpable) powder, I believe, you will find that each will just fill a box of equal dimensions; but how long each, being exposed in the field, will continue in this artificial state of equal specific gravity cannot be exactly known from any observations as yet made, though doubtless it will be the longer, by how much the more frequently they are stirred or agitated.

So much for the difference in quantity of these two sorts of soils; but the different qualities by which each hath the advantage over the other are too many for me to enumerate at present, any further than I have done in my Essay; wherein may be seen how false that assertion of Equivocus is, viz., "their (the moderns') thoughts have reached no deeper than

“ the surface of the earth, and though many sorts of timber, “ nay, Luserne, and a great many other grass seeds, require “ soils almost as deep as an oak tree does, there has not “ been one word said of it by any of them.” See my Chapters of Luserne, of St.-Foin, &c., which show this to be a false calumny; and I verily believe there is not one farmer in England that treads an acre of land, without inquiring or examining into the depth of the staple of it; the bottom of it is one of the first views his thoughts reach to, being aware, that the depth of the soil is one of the principal things whereon the success of his labour depends: though if that depth of soil should be necessary, which this pretender relates from Columella, our farmers must throw away their ploughs; for there would be neither ploughing nor planting (except in a very few places) in Britain; says he, “ his (Columella’s) words are to the following memorable effect, viz.

Nec contentos esse nos oportet, prima specie summi soli, sed diligenter exploranda est inferioris materiæ qualitas, terrena necne sit? Frumentis autem sat erit, si æque bona suberit bipedana humus, arboribus altitudo quatuor pedum abunde est.”

Which he translates thus: “ In the choice of soils we “ ought not to be contented with the upper face or surface of “ it, but should diligently seek the qualities of the inferior “ materials or strata below, to see if it be a living earth or “ good soil underneath (for so we understand the word Terrena to signify); soil of a foot thick, if it be equally good, “ will do for corn, but for the trees it ought to be four feet.”

There is no doubt but that by the words *terrena humus*, Columella here means what we call the staple or upper stratum of earth, wherein the plough is or may be properly exercised; but for this learned lawyer to translate *bipedana humus*, soil of a foot thick, instead of two feet thick, intimates a design of imposing upon his “ lower class of readers, “ who are not able to distinguish,” &c., and who would despise any author that should give them instructions to choose

a soil that is scarce possible to be found, and harder to be had. For a soil or staple of half a foot or eight inches deep would not be despised by any practical farmer.

Choice of soil, indeed, seems to be of little moment in Britain, where confiscations and forfeitures are more rare than they were in Italy in Columella's time, so that our lands are seldom taken away from the ancient owners, to be distributed to such men of merit and industry as the Equivocal Society seem to hope they will. However that may be, let us, whilst we have them, see the ancient "manner of working and" ploughing them, in all which (Equivocus says) Columella "has left directions not to be excelled, and from a quotation of two lines only from Virgil also, has said more on" the subject of tillage than all the moderns have who "wrote since; it is there, that speaking of putrid, cold, watery land, those two authors direct the ploughing of it as" the only method of bringing it into tillage." A great discovery, indeed, that land is brought into tillage by ploughing!

But what a perverter is Equivocus, when he asserts, that Virgil means putrid, cold, watery land, by *Nigra fere et pinguis terra, cui putre solum optima frumentis*; which is evidently a blackish, fat, mellow land, and the best of soils, as putrid, cold, watery land, is the very worst; for the Society say, in p. xv. of Preface to August, that the too great quantity of water standing too near the surface is as great a cause of barrenness as the entire want of it: but yet a soil that is naturally mellow, differs much from a soil which is made so by ploughing; and the most mellow soil that is, will produce but little corn without ploughing.

Equivocus, to show further his utmost ignorance in the subject he pretends to write of, gives the world the following false translation of part of Columella's 4th Chapter, Lib. xi.;

Medium igitur temperamentum maxime sequamur in arandis agris; ut neque succo careant, nec abundant uligine.

Which he renders thus in English : “That we chiefly have regard to a medium or temperature of weather in the ploughing of our fields, even so as that they may not want proper moisture for the nourishment, nor abound so much with it as to spoil the corn.” He perverts the sense of Columella by foisting in the spoiling of corn, by the too much or too little moisture, when the degree of moisture relates only to the effect it has on the pulverisation of that land ; for he must be very ignorant to think that the same degree of moisture in which the fields are ploughed, will continue in them till the corn has occasion of it, since there is always an absolute necessity of vicissitudes of weather, after this first ploughing, ere the fields can be made fit to be sown with corn.

The next thing, on account of which he extols the ancients and reproaches the moderns, is the sorts of wheat the ancient sages were possessed of, that are not sufficiently regarded by the moderns, viz., the Bimestre and Trimestre, “so called from their ripening in two or three months after they were sown.” And one of them (from Pliny) was ripe in forty days after it was sown ; but after the advantages he proposes from our sowing them, and all his quotations and etymologies of them, though the one be called *Triticum æstivum et Trimestre Portæ*, and the other *Triticum æstivum et Zeopyrum tritico speltum*, this virtuoso doth not pretend he ever saw either of them, and allows that he does not know whether they are wheat or barley ; and yet reproaches our modern authors for having “said so little of it, that it is difficult in general to understand what they sow those grains for ; though some few practical farmers in Stafford and Oxfordshire, &c., may.” If they are sown by the practical farmers so near London, it is a wonder this practical farmer should be no better informed concerning those wonderful, hasty, and advantageous grains.

The reason and truth of these ancient worthies appear

pretty equally in their erroneous poetical religion, astronomy and agriculture. Any one of them may be defended as well as the other; for that dead men are gods or stars, that the sun sets in the sea, and that pulverisation is poison to light and, are equal absurdities; and he who writes for restoring such errors of the ancients, though his language in verse or in prose should be as fine as theirs, it can be but sound instead of sense.

The other causes of the blight which are most general, and do the most damage, may in some measure be prevented.

One cause is the lodging or falling of corn; for then the stalks are broken near the ground, whereby many of the vessels are so pressed that the juices cannot pass them, and then the free circulation is hindered, the chyle cannot mount in sufficient quantity to be purified and turned into sap; the defect whereof makes the plants become languid, and only just able to live; they have strength enough to linger on to the time of their period, as in very old age, but not to bring their fruit, which is the grain, to its natural bulk, nor to fill it with flour; and the sooner the stalks fall, the less and thinner the grain will be.

Hence it often happens, that when tillage, dung, and good land have brought a crop of wheat, that in the months of April and May promise to yield the owner five or six quarters on an acre, then in June it falls down, and scarce affords five or six bushels; and that perhaps is so thin and lank, that the expense of reaping and thrashing it may overbalance its value.

That the falling down of wheat does cause the ruin of the crop, is well known; but what causes it to fall is not so plain.

And without knowing the true causes, it is not likely that a remedy should be found against the disease.

I take this weakness of the stalks, which occasions their

falling, to proceed from want of nourishment, want of air, want of the sun's rays, or of all three.

One argument that it lodges for want of nourishment is, that a rich acre has maintained a crop of five quarters standing, when another poorer acre was not able to support a crop from falling, which was but large enough to have brought three quarters, if it had stood; and this in the same year, and on the same situation. And it is very plain that if one acre was twice as rich as the other, it must be able to nourish five quarters better than the other could nourish three quarters.

Air is necessary to the life and health of all plants, though in very different degrees; aquatics, which live under water, are content with as little air as their companions, the fishes.

But wheat, being a terrestrial plant (though in winter it will live many days under water, whilst the slow motion of its sap gives it little or no increase) requires a free open air, and does not succeed so well in low shelterly places, as upon higher and opener situations, where the air has a greater motion, and can more easily carry off the recrements from the leaves, after it has shaken off the dews and rains, which would otherwise suffocate the plants; and therefore the leaves are made so susceptible of motion from the air, which frees them from the dews that would stop in the recrements at the vesiculæ of the leaves, but, shaken down, will nourish the plants at the roots: the want of this motion weakening the wheat, it is (as animals in the like sickly case are) the more unable to stand, and the more liable to be pressed down by the weight of rain-water, and more unable to rise up again when down: all which evils are removed by the free motion of the air, which shakes off both dews and rains, and thus contributes to prevent the falling (or lodging) of wheat.

A great quantity also of the sun's rays is necessary to keep wheat strong and in health; and in Egypt and other hot

countries, it is not so apt to fall as it is when sown in northern climates, though the produce of the south be the greatest.

This proves that the crop doth not lodge on account of its bigness.

It may be observed, that every leaf is inserted in to a sort of knot, which probably delivers out the sap to be depurated at the vesiculæ of the leaves, and then receives it back again for the nourishment of the plant, doing for that purpose the office of a heart; but the sun with his rays supplies the part of pulse, to keep the sap in motion, and carry on its circulation, instead of the heart's systole and diastole. Wheat being doubtless originally a native of a hot country, requires by its constitution a considerable degree of heat to bring it to perfection; and if much of that degree be wanting, the wheat will be the weaker, and when the solar rays cannot reach the lower parts of the stalks, the lowest leaves and knots cannot do their office; for which reason the chyle must mount higher before it be made into sap, and there must be then a greater mixture of crude chyle next to the ground, as by the white colour it appears. By this means that part, which, if it had a due share of the sun's influence, would be hardened like a bone or spring, for the support of the stalks; but for lack of that, becomes more like to a cartilage, soft and weak, unable to sustain the weight of the bending ear, which having its greatest impetus against this part, which is most feeble to resist it, it yields and lets it fall to the ground, and then the grain will be blighted.

But now I suspect this to be a mistake, it being more likely that the white colour of the rind is owing to the absence of the sun and free air, than to the chyle, as the skin of those parts of our own bodies that are concealed from them, is whiter than of those which are exposed to them, though no chyle-vessel comes near our skin.

There is also another cause of the blight, and that is the

wheat's coming too late into blossom; the usual time is the beginning of June, and if it be later, the days shorten so fast after the solstice, that the autumn of the year hastening the autumn of the wheat's life, the full time of its pregnancy* is not accomplished; and then its fruit, which is the grain, becomes as it were abortive, and not full grown. This time betwixt the generation, blossoming, and the maturity of the grain is, or ought to be, about two months.

Therefore it is advantageous to hasten what we can the time of blossoming, and to protract the time of ripening: and it is observed, that the earliest sown wheat generally escapes the blight the best, because it comes first into blossom.

But it was quite otherwise, it seems, in that climate where Virgil says,

“Multi ante occasum Maiæ cœpere; sed illos

“Expectata seges vanis illusit aristis.”

This, I suppose, must be where the winters are so mild, that if wheat were sown early, it might chance to blossom before the hazard of the nipping winds was past; which often happen there towards March to be the most piercing, and might destroy the tender wheat blossoms, and then the ears must be empty. The winters are so mild at Messina, as without art to produce green pease, cauliflowers, artichokes, &c., as good as we have them in summer. Therefore wheat cannot be kept back from blossoming as it is here by the

* Ut enim mulieres habent ad partum dies certos, sic arbores ac fruges. VARRO, lib. 1, cap. 44.

Mense Maio, florent sic; frumenta et ordeum et quæ sunt seminis singularis octo diebus floreant, et deinde per dies 40 grandescunt flore deposito usque ad maturitatis eventum.—PALLADIUS, pages 114, 115.

Quindecim diebus esse in vaginis, quindecim florere, quindecim exarescere, cum sit maturum frumentum.—VARRO, lib. 1, cap. 32.

But the different heat that there is in different climates, may alter both the time that plants continue in blossom, and the time betwixt the blossoming and the ripening.

frost; and if their wheat-harvest in Sicily be about the 20th of May (as I have been informed) its time of blossoming is probably in the beginning of March.

Of all the errors in the first Georgic (which I think contains little else) Virgil's remedy against the blight seems the most ridiculous.

“ Qui, ne gravidis procumbat* culmus aristis
 “ Luxuriam segetum tenerâ depascit in herbâ
 “ Cum primum sulcos æquant sata.”

And lest the stem too feeble for the freight,
 Should scarce sustain the head's unwieldy weight,
 Sends in his feeding flocks betimes t'invade
 The rising bulk of the luxuriant blade;
 Ere yet th'aspiring offspring of the grain
 O'ertops the ridges of the furrow'd plain.—DRYDEN.

This indeed prevents the blight, by doing what the blight would do if the wheat fell down, *i. e.*, causes the ears to be light†.

And we find that those who practise this method of feeding their wheat with sheep in the spring, to prevent the lodging of it, have most commonly their straw weak, and ears light.

These Virgilians, instead of making the stalks strong enough to support heavy ears, make the ears light enough to be supported by weak stalks. They know that heavy ears make the greatest crop, and yet they still hope to have it from light ones.

* All the injury that ears receive by falling is, that it makes them light, and lodged ears are always lighter than those of the same bigness which stand; therefore Virgil instead of *gravidis* should have said *levibus*, if he had a due regard to strict truth, which alone could be of any service to the subject he then wrote of; but he plainly mistook the cause of its falling, which is *stalks weak at bottom*. He blundered in the fallen wheat, whilst his eyes and thoughts were intently fixed on the sky, in order both to learn there his rules of steering his plough, and to find a vacancy wherein to place the conqueror of his own country among the *stars*.

† Heavy ears never fall, if they did, that would not make them light. Wheat falls sometimes whilst it is in grass, and before it comes into ear, so far are the ears from causing it to fall.

They cause the blight by the very means they make use of to cure it.

The feeding of wheat much retards the time of its blossoming, and that it may blossom early is one chief end of sowing it early, to prevent the blight. But when it is fed, what the plants send up next is but a sort of second or latter crop, which have longer to stand than the first would have required, and is always weaker than the first crop would have been; and the longer time it has to continue on the ground, the more nourishment is required to maintain it; and yet, as has been shown, the longer it has been sown, the more the earth has lost of its nourishment; and consequently the crop will be yet weaker and in more danger of the starving blight.

Thus Virgil's remedy seems here to be worse than the disease*.

* I am sure that whenever sheep break into my drilled wheat, in the spring, it lessens my crop half, just as far as they eat the rows.

There are several reasons why sheep are more injurious to drilled wheat than sown; I would not, therefore, be understood to decry the practice of feeding sown wheat, when the thickness and irregularity of its plants make it necessary; I have only endeavoured to show, that that practice is founded upon a false theory; for if wheat fell down by reason of the luxuriance of it, a plant of it would be more likely to fall when single and at a great distance from every other plant, than when near to other plants, because such a single plant is (*cæteris paribus*) always the most luxuriant, and I have not seen such a one fall (except birds pull down the ears), but have observed the contrary, though its ears are the largest.

The subject I write on is drilling and hoeing, and of whatsoever else I think relates to the practice or theory thereof; which obliges me to advise against drilling too thick upon any sort of land, but more especially upon very rich land; for though I have no such land, yet I apprehend that a too great number of plants may overstock the rows, and cause them to be liable to some of the inconveniences of sown wheat; and in such a case, perhaps, sheep may be rather useful than prejudicial to the drilled wheat; but of this I have had no experience; and if it should be too thick, it will be owing to the fault of the manager or driller, but I suppose it might be a better remedy to cut out the superfluous plants by the hand-hoe, in the manner that superfluous turnips are hoed out.

The most effectual remedy against the blight is that which removes all its causes (except such extraordinary ones as lightning), as,

FIRST,—Want of Nourishment.

The horse-hoe will, in wide intervals, give wheat, throughout all the stages of its life, as much nourishment as the discreet hoer pleases.

SECONDLY,—Want of Air.

Air, being a fluid, moves most freely in a right or straight line, for there the fewest of its parts meet with any resistance; as a straight river runs swifter than a crooked one, from an equal declivity, because more of the water strikes against the banks at the turnings, and is there somewhat retarded; and the rest moving no faster than in the straight river, the whole stream of the crooked must be slower in its course than that of the straight river.

The air cannot pass through sown corn in a direct line, because it must strike against and go round every plant, they standing all in the way of its course, which must stop its current near the earth.

And the air amongst sown corn is like water amongst reeds or osiers in the side of a river, it is so stopped in its course, that it almost becomes an eddy; and since air is about eight hundred times lighter than water, we may suppose its current through the corn is more easily retarded, especially near the earth, where the corn has occasion for the greatest quantity of air to pass; for though the upper part of the wheat be not able to stop a slow current of air, yet it does so much raise even a swift one, as to throw it off from the ground, and hinder it from reaching the lower parts of the stalks, where the air must therefore remain, in a manner, stagnant; and the thicker the wheat is, where it stands promiscuously, the less change of air can it have, though the greater the number of the stalks is, the more fresh air they must require.

But the confused manner in which the plants of sown wheat stand, is such, that they must all oppose the free entrance of air amongst them, from whatever point of the compass it comes.

Now it is quite otherwise with wheat drilled regularly with wide intervals, for therein the current of air may pass freely (like water in a straight river where there is no resistance), and communicate its nitre to the lower as well as upper leaves, and carry off the recrements they emit, not suffering the plants to be weakened, as an animal is, when his lungs are forced to take back their own expirations, if debarred from a sufficient supply of fresh, untainted air. And this benefit of fresh air is plentifully and pretty equally distributed to every row in a field of hoed wheat.

THIRDLY,—Want of the Sun's Rays.

Sown wheat-plants, by their irregular position, may be said to stand in one another's light, for want of which they are apt to fall.

It is true, the whole field of plants receive the same quantity of sunbeams amongst them, whether they stand confusedly or in order; but there is a vast difference in the distribution of them, for none, or the very least share of beams, is obtained by those parts which need the greatest share in the confused plants. And when the crural parts, that should support the whole body of every plant, are deprived of their due share of what is so necessary to strengthen them, the plants (like animals in the same case) are unable to stand.

But in drilled wheat, where the plants stand in a regular order, the sunbeams are more duly distributed to all parts of the plants in the ranks; for which way soever the rows are directed, if they be straight, the rays must, some time of the day, fall on the intervals, and be reflected by the ground, whence the lower parts of the wheat stalks must receive the

greater share of heat, being nearest to the point of incidence, having no weeds to shadow them.

As to that cause of the blight, viz., the wheat's dying before the full time of its pregnancy be accomplished ; the hoe removes all the objections against planting early, and then it will blossom the earlier : and it has visibly kept wheat green a whole week longer than unhoed wheat adjoining to it, planted the same day.

The ancients were perfect masters of the vine-husbandry, which seems to have engrossed their rural studies, that it did not allow them so much reflection, as to apply the use of those methods to the increase of bread, which they had discovered to be most beneficial for the increase of wine. One method was to hoe the vines after they had blossomed, in order to fill the fruit, as in Columella, lib. iv. cap. 28. *Convenit tum crebris fossionibus implere, nam fit uberior pulverationibus.* And if what Palladius says, Tit. ix., be true of the sarritions and sarculations in the month of January, and that if beans do twice undergo that scratching operation, they will produce much fruit, and so large as to fill the bushel almost as full when shaled as unshaled.

Faba si his sarculeretur proficiet, et multum fructum et maximum, afferet, ut ad mensuram modii complendi fresa propemodum sicut integra respondeat.

This is to be done when beans are four fingers high, and corn when it has four or five leaves to a plant ; even then the harrowing-work, though it tore up some of the plants, yet it was observed to do good against the blight.

Si siccas segetes sarculaveris, aliquid contra rubiginem præstitisti maxime si ordeum siccum sarrietur.

When the ancients observed this, it is wonder they did not plant their corn so as to be capable of receiving this benefit in perfection. They might have imagined, that what was

effectual against the blight, when the corn was in grass, must in all probability be much more effectual when in ear.

But the most general blight that happens to wheat in cold climates, is caused by insects, which (some think) are brought in the air by an east-wind accompanied with moisture, a little before the grain is filling with that milky juice which afterwards hardens into flour. These insects deposit their eggs within the outer skin (or rind) of the stalks; and when the young ones are hatched, they feed on the *parenchyma*, and eat off many of the vessels which should make and convey this juice; and then the grain will be more or less thin in proportion to the number of vessels eaten, and as the insects happen to come earlier or later; for sometimes they come so late, that the grain is sufficiently filled with the said milky juice before the vessels are eaten; and then, though the straw appear through a microscope to have its vessels very much eaten and torn, and to be full of black spots (which spots are nothing else but the excrements of those young insects), yet the grain is plump and not blighted, there being an observation, that the early-sown wheat generally escapes this blight. And it has been seen, where one part of a field is sown earlier than the other part, without any other difference than the time of sowing, that the grain of the latest sown has been much blighted, and the grain of the earlier has escaped the blight, though the straw of both were equally eaten by the insects. Hence it may be inferred, that the milk in the one had received all the nourishment necessary to its due consistence, before the vessels were destroyed; but in the other, the vessels, which should have continued the supply of nourishment for thickening the milk, being spoiled before they have finished that office, it remains too thin; and then the grain, when it hardeneth, shrinks up and is blighted; yet the grain of one and the other are equally plump until they become hard; the difference, therefore, is only in the

thickness of the milk, that in the blighted being more watery than the other.

The chief argument to prove that these insects are brought by an east-wind, is, that the wheat on the east-sides of hedges are much blighted, when that on the west-sides is not hurt; and as to the objection, that they are bred in the earth, and crawl thence up the stalks of the wheat, because some land is much more subject to produce blighted wheat than other land is, perhaps this difference may be chiefly owing to the different situation of those lands, as they are opposed to the east or to the west.

Another cause why some wheat is more blighted than other wheat on the same land is, the different condition in which the insects find it; for the rind of that which is very strong and flourishing* is soft and tender; into this they can easily penetrate to lay their eggs; but the wheat that is poor and yellow, has a hard tough skin (or rind), into which the insects are not able to bore, for the intromission of their eggs, and therefore can do it no mischief. It would be in vain to advise to prevent the blight, by striving to make the wheat poor; for though poverty may preserve wheat from this blight, as well as it does people from the gout, yet that is a remedy which few take willingly against either of these diseases; but this I think might be possible to remedy it, if we could from the strongest wheat take away so much nourishment as to turn its colour (but this is a very difficult matter) a little yellowish just before the insects come†, which

* Some sort of land is more subject to this blight than others; in such, Lammas-wheat must by no means be drilled late and too thin, lest it should not tiller till late in the spring; and then, for want of a sufficient quantity of stalks to dispense with all the nourishment raised by the hoe, may become too vigorous and luxuriant, and be the more liable to the injury of the blight of insects.

† Whither those insects go, or where they reside, from the time of their eating their way out of the straw, until they return the next year, I cannot learn.

I suppose to be in June, after the ear is out, or at least fully formed.

Yet this can only be done in wide intervals ; for unless the fine earth can be thrust to some considerable distance from the roots after they are cut off, they will soon shoot out again and reach it, becoming more vigorous thereby.

In dry summers this misfortune seldom happens, much heat and very little moisture being most agreeable to the constitution of wheat ; for then its rind is more firm and hard, as it is on the contrary made more soft and spongy by too much moisture.

The most easy and sure remedy that I have yet found against the injury of these insects, is to plant a sort of wheat that is least liable to be hurt by them, viz., the white-cone (or bearded) wheat, which has its stalk or straw like a rush, not hollow, but full of pith (except near the lower part, and there it is very thick and strong), it is probable it has sap-vessels that lie deeper, so as the young insects cannot totally destroy them, as they do in other wheat : for when the straw has the black spots, which show that the insects have been there bred, yet the grain is plump, when the grey-cone and Lammas-wheat mixed with it are blighted. This difference might have been from the different times of ripening, this being ripe about a week earlier than the grey-cone, and later than the Lammas ; but its being planted together both early and late, and at all times of the wheat-seed time, and this white-cone always escaping with its grain unhurt, is an argument, that it is naturally fortified against the injury of these insects, which in wet summers are so pernicious to other sorts of wheat ; and I can impute it to no other cause than the different deepness of the vessels, the straw of other wheat being very much thinner and hollow from top to bottom, this having a small hollow at bottom, and there the thickness betwixt the outer skin and the cavity is more than double to that in other sorts of wheat ; so that I imagine, the

insects reach only the outermost vessels, and enough of the inner vessels are left untouched to supply the grain.

This wheat makes very good bread, if the miller does not grind it too small, or the baker make his dough too hard, it requiring to be made softer than that of other flour.

A bushel of this white-cone wheat will make more bread than a bushel of Lammas, and of the same goodness; but it gives a little yellow cast to the bread.

Another sort of lodging blight there is, which some call Moor-Loose, and mostly happens on light land: this is when the earth, sinking away from the roots, leaves the bottom of the stalk higher than the subsided ground, and then the plant having only these naked roots to support it (for which they are too weak) falls down to the earth.

To remedy this, turn a shallow furrow against the rows, when they are strong enough to bear it, and when the mould is very fine and dry; then the motion of the stalks by the wind will cause such earth to run through the rows, and settle about the roots and cover them.

Some land is very subject to the misfortune of exposing the roots, and therefore is less proper for wheat; for when the roots are left bare to the air, they will be shrivelled and unable to support the plants: and on such lands the wheat plants have all fallen down, though in number and bigness not sufficient to have produced the fourth part of a tolerable crop if they had stood.

I am inclined to believe, that a thorough tillage might be a remedy to such a loose hollow soil; for it is certain, to a demonstration, that it would render it more dense, and increase its specific gravity; but to enrich it sufficiently without manure the tillage must pulverise it much more minutely, and expose it longer than is required for the strongest land. The fold also will be very helpful on such hollow land; but the long strawy dung, that Equivocus prescribes to it, must needs make it more hollow.

I have never seen any drilled wheat so much spoiled by falling, as sown wheat sometimes is. The drilled never falls so close to the ground, but that the air enters into hollows that are under it, and the wind keeps the ears in motion. Notwithstanding all the precaution that can be used, in some unseasonable years wheat will be blighted: I have known such a general blight, when some of my Lammas-wheat, planted late, and on blighting land, was blighted amongst the rest of my neighbours', by the insects; but the grain of the sowed wheat was vastly more injured than that of the drilled: the former was so light, that the greatest part was blown away in winnowing, and the remainder so bad, that it was not fit to make bread: the drilled made as good bread, and had as much flour in it, as the sowed wheat had, that was not blighted; for the grains of the drilled were much larger than those of the sown; being formed to have been twice as big as the grains of wheat generally are, had they not been blighted.

CHAPTER XIV.

OF ST.-FOIN.

ST.-FOIN, from the country we brought it from, is called French Grass: and for its long continuance, some having lasted forty years, it is called Everlasting Grass, though it be not strictly a *gramen*.

It is called in French, *Sain Foin*, i. e., *Sanum Fœnum*, from its quality of wholesomeness, beyond the other artificial grasses, green and dry. It is also called *Sanctum Fœnum*, Holy Hay.

It is a plant so generally known to every body (except a certain author, who confounds it with *Medica*) that there is no need to give any formal description of that part of it which appears above ground. It has many red flowers, sometimes leaving ears five or six inches long: I have measured stalks, and found them above five feet long, though they are commonly but about two feet.

The reason why St.-Foin will, in poor ground, make a forty-times greater increase than the natural turf, is the prodigious length* of its perpendicular tap-root; it is said to

* There is a vulgar opinion, that St.-Foin will not succeed on any land where there is not an under stratum of stone or chalk, to stop the roots from running deep; else, they say, the plants spend themselves in the roots only, and cannot thrive in those parts of them which are above the ground. I am almost ashamed to give an answer to this.

It is certain that every plant is nourished from its roots (as an animal is by its guts) and the more and larger roots it has, the more nourishment it receives, and prospers in proportion to it. St.-Foin always succeeds where its roots run deep, and when it does not succeed, it never lives to have long roots; neither can there ever be found a plant of it, that lives so

descend twenty or thirty feet. I have been informed by a person of undoubted credit, that he has broke off one of these roots in a pit, and measured the part broken off, and found it fourteen feet.

This tap-root has also a multitude of very long horizontal roots at the upper part thereof, which fill all the upper stratum, or staple of the ground; and of thousands of St.-Foin roots I have seen taken up, I never found one that was without horizontal roots near the surface, after one summer's growth; and do much wonder how Mr. Kerkham should be so mistaken, as to think they have none such.

Also these tap-roots have the horizontal ones all the way down; but as they descend, they are still shorter and shorter, as the uppermost are always the longest.

Any dry ground may be made to produce this noble plant, be it never so poor; but the richest soil will yield the most of it, and the best.

If you venture to plant it with the drill, according to the method wherein I have always had the best success, let the land be well prepared before you plant it. The seed, if not well ordered, will very little of it grow; therefore it is convenient to try it in the manner mentioned in chapter "Of Hoeing;" where are also directions to find the proper quantity and depth to plant it at: I have observed that the heads of these

long as to root deep in a soil that is improper for it. Therefore it is amazing to hear such reasoning from men.

An under stratum of very strong clay, or other earth which holds water, may make a soil improper for it; because the water kills the root, and never suffers it to grow to perfection, or to attain to its natural bulk. The best St.-Foin that ever I saw, had nothing in the soil to obstruct the roots, and it has been found to have roots of a prodigious depth.

If there be springs near, or within several feet of, the surface of the soil, St.-Foin will die therein in winter, even after it has been vigorous in the first summer, and also after it hath produced a great crop in the second summer.

seeds are so large, and their necks so weak*, that if they lie much more than half an inch deep†, they are not able to rise through the incumbent mould; or if they are not covered, they will be malted‡. A bushel to an acre is full twenty

* The kernel or seed, being much swollen in the ground, I call the head; this, when it reaches above the ground, opens in the middle, and is formed into the two first leaves; the husk always remaining at the same depth at which it is covered: the string that passes from the husk to the head, is the neck; which, when by its too great length it is unable to support the head till it reaches to the air, rises up and doubles above it; and when it does so, the head being turned with its top downward, never can rise any higher, but there rots in the ground.

† In very light land the seed will come up from a greater depth; but the most secure way is, not to suffer it to be covered deep in any land.

I am told (but I believe it may be my mistake, I never having seen Mr. Miller's book) that Mr. Miller in his *Gardener's Dictionary* affirms, that St.-Foin seed will come up when planted seven or eight inches deep. If any one has planted it with a gage at that depth, and seeing it come up, has taken it out of the ground, measured the neck between the husk and the two first leaves, and found it to be of the mentioned length, he must believe it; but without such a trial, I own it is to me very incredible. It has indeed in very hollow, puffy, new-broke meadow-land, come up from something above two inches depth, its neck being of that length; but here the mould was so exceeding light and hollow, that it made very little resistance against the rising head: in common arable land I never saw a St.-Foin neck so long, and I have examined a multitude of them. I have also found many hundreds of them to miscarry by not being able to push their heads through the incumbent mould when covered but half an inch deep in the channels, when a sudden dash of rain has come upon white land immediately after drilling.

Perhaps some may imagine, that St.-Foin comes up from a great depth, when sown under furrow: but this is a mistake; for it is only the seeds which lie shallow that come up, the deep are all buried. Of the great quantity they sow, there are always enough that lie shallow; for the furrow in turning doth not throw the seeds all under it when the earth is fine, and the seeds (their husks making them of less specific gravity than the earth) rise upwards when moved by the harrow-tines; and the greatest part of such a large quantity of seeds being buried and dead is often a great advantage to the crop; for should they all come up, the land might be unmeasurably overstocked with plants.

‡ We say it is malted when it lies above ground, and sends out its root, which is killed by the air. And whether we plant bad seed that does not grow, or good seed buried or malted, the consequence will be much the same, and the ground may be equally understocked with plants.

seeds to each square foot in all I tried ; but there is odds in the largeness of it, which makes some difference in the number.

The worst seasons to plant it are in the beginning of winter, and in the drought of summer : the best season is early in the spring.

It is the stronger when planted alone, and when no other crop is sown with it*.

If barley, oats, or other corn sown with St.-Foin do lodge, it will kill† the young St.-Foin that is under it ; but then so great a crop of corn will certainly answer the very little expense of drilling the St.-Foin again, either the next year, or as soon as the corn is off the ground.

St.-Foin, drilled betwixt rows of barley or oats, always is stronger than when drilled amongst corn that is sown at random ; and therefore is in less danger of being killed by the lodging of the corn ; neither is the corn in rows so liable to fall as the other.

The quantity of seed to be drilled on an acre will depend in great measure upon the goodness of it ; for in some bad

* The worst crop that can be sown amongst St.-Foin, is clover or ryegrass ; barley or oats continue but a little while to rob it, but the other artificial grasses rob it for a year or two, until the artificial pasture is near lost ; and then the St.-Foin never arrives to half the perfection as it will do when no other grass is sown amongst it.

The injury these hay-crops do to the St.-Foin is best seen where some parts of the same field have them, and the other parts are without them.

† When barley, among which the St.-Foin is planted in a dry summer is great, there are few farmers that know till the next spring whether the St.-Foin succeeds or not ; because the young plants are not then visible ; unless it be to those who are accustomed to observe them in all the degrees of their growth. I have seen a field of ten acres of such, wherein, after the barley was carried off, nothing appeared like St.-Foin ; but when, by the print of the channels, I searched diligently, I found the small St.-Foin plants thick enough in the rows ; they had no leaves, they being cut off by the scythe, no part of them that was left had any green colour ; but from the plants there came out many sprigs like hog's bristles, or like the beard of barley ; this whole piece of St.-Foin succeeded so well, that the third year its crop was worth three pounds per acre, the land being good.

seed not more than one in ten will grow, and in good seed not one in twenty will miss ; which is best known by stripping off the husks of a certain number of seeds and planting the kernels in earth, in the manner directed for finding the proper depth to plant at, which in this case let be half an inch ; this being done, the quality of the seed will be known ; but until frequent trials have furnished experience enough to the planter to know the difference, let him observe that the following are good signs, viz., the husk of a bright colour, the kernel plump, of a light grey or blue colour, or sometimes a shining black ; yet the seed may be good though the husk is of a dark colour, if that is caused by its receiving rain in the field, and not by heating in a heap, or in the mow ; and if you cut the kernel off in the middle, cross-wise, and find the inside of a greenish fresh colour, it is surely good ; but if of a yellowish colour, and friable about the navel, and thin, or pitted, these are marks of bad seed.

The quantity, or rather number of seeds convenient to drill, ought to be computed by the number of plants* we propose to have for making the best crop, allowing for casualties†.

* Not that we need to be so exact as to the number of plants, whether they be two, three, or four hundred upon a square perch. Neither is it possible to know beforehand the precise number of plants that may live, for sometimes the grub kills many by eating off the first two leaves.

† Many, even of the best seeds, both sown and drilled, are liable to casualties, but not equally ; for about twenty-eight years ago, my servants (being prime seedsmen) had a fancy in my absence to try an experiment of the difference betwixt sowing and drilling of St.-Foin ; and in the middle of a large field of my best land they sowed a square piece of three acres, at the rate of one bushel to an acre, not doubting, but by their skill in sowing even, it would succeed as well as if drilled ; but it succeeded so much against their expectation, that the land all round it, which was drilled at the same time, with the same proportion of the same seed, brought extraordinary good crops of St.-Foin ; but the sowed part was so very thin, that though it layed still with the rest for eight years, it never was a crop, there not being above three or four upon a square perch, taking the three

In drilling St.-Foin not to be hoed, and before the ploughs of my drill were so perfect in making narrow channels as they are now (for when the channels were open they had six times the breadth, wherein part of the seed was wasted), then my quantity was one bushel to an acre, sometimes six gallons.

But a single acre (in the middle of a large field of St.-Foin) being drilled late in October, the frosty winter killed at least nineteen of twenty parts* of that bushel. At first it made such a poor appearance, that it was by mere accident or it had been ploughed up for a fallow; but missing of that, a few plants were perceived in the summer, which by their singleness grew so vigorous and so very large, that the second year of mowing it produced a crop double to the rest (but note, this acre was dunged and in better order than the rest,) of the same field which was drilled in the spring, with the same proportion of seed, and none of it killed; though all this field was a much better crop than some that was sown in the common manner, with seven bushels to an acre. I have generally observed the thin† to make the best crop, after the first or second year.

acres altogether; not that it can be supposed that the sown would always meet with so many casualties as this did; for then eight bushels sown to an acre might have been too thin, and much thinner than all the rest of the field was, though drilled with only one bushel to an acre; and it is often seen, that when an acre is sown with seven bushels of seed, the St.-Foin is as much too thick, as that sown with one bushel was too thin.

I do not know, that of the many hundred acres of St.-Foin that have been drilled for me, ever one acre was too thin, except when planted with wheat the young plants were killed by the frost.

* But I believe there might remain alive three or four plants to each square yard, standing single, and at pretty equal distances.

† But notwithstanding I commend the planting of St.-Foin thin, that most of the roots may be single, yet I have fields that were drilled with but four gallons of seed to an acre; and yet the rows being seven inches asunder, the roots are so thick in them that the ground is covered with the St.-Foin plants, which seem to be as thick (in appearance) as most sown St.-Foin, whereon seven or eight bushels are sown on an acre. And I have

I have also often observed in lands of St.-Foin, lying dispersed in a common field (but where there was not common for sheep), and where the ends of other lands kept in tillage, pointed against the pieces of St.-Foin, and the horses and ploughs turning out upon the St.-Foin, did plough and scratch out a multitude of its plants (this ploughing and scratching was a sort of hoeing which helped the St.-Foin by a small degree of pulverisation, as well as by making the plants thinner); so that it was thought to be spoiled, and law-suits were intended for recompense of the damage; but afterwards this scratched part, supposed to be spoiled, became twice as good as the rest of the same pieces, where the plough did not come to tear up any plants.

The reason why the single St.-Foin plants make the greatest crops, is, that the quantity of the crop is always in proportion to the quantity of nourishment it receives from the earth, and those plants which run deepest will receive most, and such as are single will run deeper than those which are not single.

Also the single do send out all round them horizontal roots, proportionably stronger and larger, whereby they are better able to penetrate, and extract more nourishment from the staple or upper stratum, than the other can do (if there be a competent number, which is, when hoed, fewer than any body imagines). It is common to see a single St.-Foin have a bigger tap-root than twenty thick ones; their length is in proportion to their bigness, therefore that single plant may well be supposed to have twenty times more depth of earth

other fields that were drilled with about two gallons of seed to an acre (which is five seeds to each square foot), the rows sixteen inches asunder, that produce better crops, though the ground be poorer. The drilled St.-Foin being regular is more single, though as thick as the sown, and for that reason always makes a better crop, and lasts longer than the sown that is of the same thickness but irregular.

to supply it than all those twenty small roots can reach to. And though these under strata are not so rich as the upper, yet never having been drained by any vegetable, they do afford a very considerable quantity of nourishment to those roots which first enter them.

The small thick plants are so far from equalling the product of the single by their excess of number, that the more they are, the smaller, shorter, and weaker they become, less nourishment they have, and the less crop they produce; and are soon starved, decay, and die, unless relieved by the expense of frequent manure, or that the soil be very rich.

Single plants exceed the other by a multitude of degrees, more than a giant does a dwarf, in strength as well as stature; and therefore when natural grass happens to come, are so much the better able to shift amongst it.

The single plants seem also to exceed the other in their longevity; for it is observed, that all St.-Foin that has continued good for a great number of years, without manure, has been so single, that the owners have determined to plough it up at the beginning for the thinness of it.

How long this may last by culture I cannot tell, but undoubtedly much longer than without it; and I can say, that I never knew a plant of St.-Foin die a natural death; the most common end of it is starving. And when a hundred thick plants have not the nourishment which one single plant has, it is no wonder that these (in a crowd* thus besieged with hunger) should be starved before it.

Another advantage the single have, in respect of moisture, these reach to a depth where that is never wanting, even when the upper stratum or staple is parched up, as appears by the mint (G) in the glass and box, that if any root of a plant has

* Sown plants when too thick are crowded on every side, but those that are drilled, have always room enough on two sides of them; unless the rows are too near together.

moisture, that root will communicate a share to all the rest. Hence it is, that in the driest summer, these single plants make a great crop, when the other yield next to nothing. I remember I once saw a farmer coming out of a ground with a load of St.-Foin hay, which he assured me was all he could find worth cutting out of forty acres, of this thick sort in full perfection, three years after sowing; he valued his load at three pound, but withal said, it came off so much ground, that the expense of mowing, raking, &c., was more than the value. When in the very same dry summer, there was three ton of St.-Foin to an acre in a field, where it was drilled single and regularly.

This was on rich deep land in Oxfordshire; and the other St.-Foin, which was so poor, was on thin sclate land near Causham in Wiltshire, in the Bath road. It is now about thirty years since.

And I have often observed, that where the plants are thin, the second crop of them springs again immediately after cutting; when plants that stand thick in the same ground, spring not until rain comes; and I have seen the thin grown high enough to cut the second time, before the other began to spring.

The best way to find what number of these plants is proper to have on a perch of ground, is to consider what quantity of hay one large plant will produce (for if cultivated they will be all such).

Without culture these plants never attain to a fourth part of the bulk they do with it, therefore very few have seen any one plant at its full bigness; one plant well cultivated has in the same ground made a greater produce than one thousand small ones uncultivated.

But the hay of a large single-cultivated plant will weigh more than half a pound; and 112 plants upon a square perch, weighing but a quarter of a pound a-piece one with another, amount to two ton to an acre.

If St.-Foin be planted on some sorts of land early in the spring and hoed, it may bring a crop the same summer; for I once planted a few seeds of it on sandy ground in my garden at the end of February, which produced large plants above two feet high, that went into blossom the following June, though there was a severe frost in March, which killed abundance of wheat, yet did not hurt these plants: this shows that St.-Foin is a quicker grower, unless it be planted on poor, cold ground, or for want of culture.

And though the poor land and ill management, generally allotted to it, causes it to yield but one mowing crop a-year, yet it has yielded two great ones on rich sandy land, even when sown in the common, ordinary manner.

Thin St.-Foin cannot be expected to cover all the ground at first, no more than an orchard of apple-trees will, when first planted, at thirty feet distance from each other every way; yet this is reckoned a proper distance to make a good and lasting orchard. But if these should be planted at three feet distance as they stand in the nursery, it would not be more unreasonable than the common method of sowing St.-Foin is; and there would be much the same consequence in both, from covering all the ground at first planting; except that the St.-Foin being abundantly longer rooted downwards than apple-trees are, has the greater disadvantage, when by its thickness it is prevented from growing to its full bulk and length of roots*.

The difference is only this, people are accustomed to see apple-trees planted at their due distance, but few have seen St.-Foin planted and cultivated at the distance most

* Horizontal-rooted plants suffer no greater injury by their pastures being overstocked than cattle do; because their pasture lying near the surface of the ground, they have it all amongst them; but St.-Foin, and other long tap-rooted plants, suffer yet more, because great part of their overstocked pasture is lost by them all, when they hinder one another from reaching down to it, by shortening one another's roots, which they do when they all become dwarfs by reason of their over-thickness.

proper to St.-Foin, or ever considered about it [so much as to make the necessary trials.

I have constantly found, that upon doubling any number of narrow rows, having an equal number of plants in each row, the crops have been very much diminished; and upon leaving out every other row, that is, lessening the number of rows to half, the crops are increased: and where two rows are wide asunder at one end of a piece, and near at the other end, the plants are gradually less and less, as the rows approach nearer together.

We ought never to expect a full crop of St.-Foin the first year, if we intend to have good crops afterwards; and that it shall continue to produce such, for the same reasons that must be given for planting an orchard at other distances than a nursery.

But when it has been planted on rich sandy land and proper, it has produced very great crops the first year; but then the summer wherein it grew amongst the barley must not be reckoned as the first year.

The common error proceeds from mistaking the cause of a great or small crop.

When the spaces betwixt rows are wide (if there be not too many plants in them) we always see the St.-Foin grow large, and make the greatest crop; but when it is young, or after cutting, we see room (as we fancy) for more of such plants, to make a yet larger crop; not considering that it is the wideness of those spaces, and less number of plants, that cause the crop to be so large, there being more pasture for those plants.

Where these spaces are narrower, and the rows of equal thickness, we see the plants less when grown, and that they make a less crop, and yet there seems to be room for more rows, which we fancy might make the crop larger, not considering that it is the narrowness of those spaces that cause

the plants and crops to be less for want of sufficient pasture.

Thus fondly increasing the number of our rows and plants, we bring our crop (unless the soil be rich) to nothing, by too much overstocking their pasture; and if that pasture be overstocked, the crop will be diminished more than in proportion to that overcharge; for perhaps it is not impossible to prove (if we would be curious) that plants by wanting a fourth part of their due quantum of nourishment, will be diminished to half* of their bulk they would have attained to, had they been supplied with the other fourth part.

I have observed hoed St.-Foin to grow more, and increase its bulk more in two weeks, than unhoed St.-Foin in the same ground (and without any other difference) have done in six weeks: and the quicker it grows by being better fed, the sweeter and richer food it will make for cattle, whether it be spent green or dry†.

At whatever distance the rows be set, if they have too many plants in them, the crop will be very much injured; and the greater the excess is beyond the just number, the more void space there will be amongst them; because the smaller the plants are, the less ground they cover.

I have had the experience of drilling at all distances, from thirty-three inches to seven inches, betwixt the rows; and recommend the following distances for the different methods of drilling; whether the St.-Foin be designed for hoeing or not. As,

First, for horse-hoeing; I think it is best to drill double

* When plants have not their due nourishment they suffer the more by cold and drought, so that want of nourishment diminishing their growth one-fourth, cold or drought, or both may diminish it another fourth.

† Cattle are the best judges of the goodness of grass, and they always choose to feed on St.-Foin that is most vigorous, and refuse that which is poor and yellow. And the richest, sweetest grass will always make the best hay; for the drying of it does not change the quality of the grass.

rows with eight-inch partitions, and thirty-inch intervals; which need only be hoed alternately, leaving every other interval for making the hay thereon.

Indeed I have never yet had a whole field of hoed St.-Foin; but have enough to show, that horse-hoeing makes it strong upon very poor land, and causes it to produce two crops a-year upon indifferent land.

It is not necessary to hoe this every year; but we may intermit the hoeing for three or four years together, or more if the land be good.

Whilst the plants are small the first year, care must be taken not to cover them with the plough; afterwards there will be no great danger, especially in winter, the earth not being suffered to lie on them too long.

Secondly, for hand-hoeing, drill the rows sixteen inches asunder, and single out the plant so as to make them eight inches apart, at least, in the rows, contriving rather to leave the master-plants, than to be exact in the distance. This must be done whilst they are very young, or in summer; else they will come again that are cut off by the hoe.

Lastly, when St.-Foin is drilled without any intention of hoeing, the best way I think is to plant single rows at eight inches distance, with no greater quantity of seed than when the rows are at sixteen inches distance; because, by this method, the same number of plants in the rows that are but eight inches apart, will be much more single, than in the rows at sixteen inches apart are, without being set out by the hoe.

Which of these methods soever is practised, the land should be made as clean from all grass, and as well pulverised as possible before drilling.

The tines of the drill-harrow must exactly follow the shares, which leaving the channels open, the tines cover the seed, some at bottom, and some on each side: so that it is covered very shallow, though it lies deep within the ground,

where there is more moisture than nearer to the upper level surface; this causes the seed to come up in dry weather, and yet it is not in danger of being buried by a too great weight of mould incumbent on it.

But take heed that no other harrow come on it after it is drilled, for that might bury it. I never care to roll it at all, unless on account of the harley, and then only in very dry weather, with a light roller, lengthwise of the rows immediately after it is drilled, or else stay three weeks afterwards before it be rolled, for fear of breaking off the heads of the young St.-Foin.

Be sure to suffer no cattle to come on to the young St.-Foin the first winter*, after the corn is cut that grows amongst it; their very feet would injure it by treading the ground hard, as well as their mouths by cropping it: nor let any sheep come at it, even in the following summer and winter.

One acre of well-drilled St.-Foin, considering the different goodness of the crops and the duration of it, is generally worth two acres of sown St.-Foin on the same land, though the expense of drilling be twenty times less than the expense of sowing it.

* The first winter is the time to lay on manure, after the crop of corn is off, such as peat-ashes or the like; because there being no natural grass to partake of it, and the plants being less, less will supply them; and because, when made strong in their youth, they will come to greater perfection but I never use any manure on my St.-Foin.

It was because mine generally had no occasion for manure before it was old; and soot is seldom to be had of sufficient quantity in the country, and little coal is burnt hereabouts, except by the smiths, whose ashes are not good. The price and carriage of peat-ash will be ten shillings for an acre, which would yet be well bestowed in a place where hay is vendible: but by reason of the great quantity of watered meadows, and plenty of St.-Foin, clover, and hay, raised of late years by farmers for their own use, here are now few or no buyers of hay, especially these open winters: so that laying out money in that manner, would be in effect to buy what I cannot sell. I think it better to let a little more land lie still in St.-Foin, than to be at the expense of manure; but yet shall not neglect to use it, when I shall find it likely to be profitable to me.

One of the causes why St.-Foin that is properly drilled lasteth longer* without manure than the sown, is, that the former neither over nor under-stocks the pasture, and the latter commonly, if not always, doth one or the other, if not both; viz., plants too thick in some places and too thin in others; either it is not single but in bunches; or if it be single it is too thin, it being next to impossible to have the plants come true and regular, or nearly so, by sowing at random. Plants too thick soon exhaust the pasture they reach, which never is more than a small part of that below the staple; when the plants are too thin, the St.-Foin cannot be said to last at all, because it never is a crop.

They who sow eight or ten bushels of good seed on an acre in a good season among their corn, with intent that by its thickness it should kill other grass, reduce their St.-Foin almost to that poor condition I have seen it in, where it grows naturally savage without sowing or tillage, upon the Calabrian hills near Croto. It makes there such a despicable appearance, that one would wonder how any body should have taken it in their head to propagate so unpromising a plant; and yet there has scarce been an exotic brought to England in this or the last age, capable of making a greater or more general improvement, were it duly cultivated.

Some think the Cythisus would exceed it; but I am afraid the labour of shearing those shrubs by the hands of English servants would cost too much of its profit.

Lucerne requiring more culture, and being much more difficult to be fitted with a proper soil, never can be so general as St.-Foin.

Mr. Laurence, in his new System of Agriculture, page 400,

* I have now a great many single St.-Foin plants in my fields that are near thirty years of age, and yet seem as young and vigorous as ever; and yet it is common for thick St.-Foin to wear out in nine or ten years, and in poor land much sooner, if not often manured by soot, peat-ash, or coal-ash.

is in hopes of succeeding in his project of cultivating assa-foetida in England in lieu of St.-Foin, and that it may be a greater improvement than it or clover. But I must beg leave to suspect a little his sincerity, when he delivers his opinion, that sheep fatted with silphium or assa would make mutton of such a wonderful pleasant taste, as to be preferable and more delicate than that of Bagshot-Heath; especially when he relates, that one drachm of it fresh from the roots, casts a stronger smell than one hundred pound of it sold by our druggists; and how 'the whole air of a place is infected with its noisome stench; and that Ronodæus thinks the Indian palates are made of brass to endure it.'

Upon the whole, this reverend gentleman's meaning (for all good men mean well) seems to be for introducing silphium as an improvement of another kind than that of St.-Foin, viz., that if he could prevail with the English to plant assa all over the island as frequent as St.-Foin and clover are; so that by assuetude, English noses might become as brazen as those of Ronodæus's Indians (for those of the London gold-finders would be a million of times too nice), then Mr. Laurence's project would be an extraordinary improvement, and save the immense charge of a fleet to defend us; for though we had no other guard but only this general stench of assa, it would be as dangerous for any European army to approach England, as for serpents and toads to invade Ireland. When this contrivance succeeds, Mr. Laurence will deserve no less of his country, than St. Patrick did of his. But because it may probably be a long time before this contrivance be so fully effected, as to bring St.-Foin quite out of fashion, let us consider in the interim the best methods of ordering it for hay and for seed. The profit of St.-Foin fields arising from either of these ways, is a great advantage to their owner, above that of natural meadows; for if meadow-hay cannot have good weather to be cut in its season, it can serve for little

other use than as dung, and yet the expense of mowing it and carrying it off must not be omitted. But if there be not weather to cut St.-Foin before blossoming, we may expect it till in flower, or may stay till the blossoms are off; and if it still rain on, may stand for seed, and turn to as good account as any of the former; so that it has four chances to one of the meadow.

The elevated but not mountainous situation of the dry land whereon St.-Foin is mostly planted, renders it so commodious for making of hay, that it escapes there the injury of weather, when hay in low meadows is utterly spoiled.

On the high ground the wind will dry more in an hour than on the meadows in a whole day. The sun too has a more benign influence above, and sends off the dew about two hours earlier in the morning, and holds it up as much longer in the evening. By these advantages the St.-Foin has the more time to dry, and is made with half the expense of meadow-hay.

But before the manner of making it be described, the proper time of cutting it ought to be determined; and upon that depend the degrees of its excellence (besides the weather, which is not in our power); for though all sorts of this hay if well made be good, yet there is a vast difference and variety in them.

The several sorts may be principally distinguished by the following terms, viz., first, the virgin; secondly, the blossomed; thirdly, the full-grown; and fourthly, the thrashed hay.

The first of these is best of all beyond comparison, and (except lucerne) has not in the world its equal. This must be cut before the blossoms appear; for when it stands until full blown, the most spirituous, volatile, and nourishing parts of its juices are spent on the next generation; and this being done all at once, the sap is much depauperated, and the St.-Foin can never recover that richness it had in its virgin state. And

though when it blossom it be literally in the flower of its age, it is really in the declension of it. If it be said, that what is not in the stalk is gone into the flower, it is a mistake, because much the greatest part of its quintessence perspires thence into the atmosphere.

And moreover, that all vegetables are in some degree weakened by the action of continuing their kind, may be inferred from those plants which will live several years, if nor suffered to blossom; but whenever they blossom, it causes their death, though in the first year of their life. For in plants (as Dr. Willis observes in animals) nature is more solicitous to continue the species, than for the benefit of the individual.

Part of a drilled St.-Foin ground was cut the beginning of May, before blossoming*, and from the time of cutting, until it was set up in ricks, being about ten days, the sun never shone upon it, but the weather was misty; at last it was forced to be carried together for fear of rain, so green that out of the largest stalks one might wring milky juice; yet by making the hay up in several little ricks, and drawing up a great chaff basket in the middle of each, its firing was prevented: but it looked of a dark colour by heating; and was the very best† hay that ever I had.

* By cutting before blossoming is not meant before any one blossom appears, for here and there a bud will begin to open with a red colour long before the rest; therefore, when we perceive only a very few blossoms beginning to open (perhaps but one of a thousand), we regard them as none.

† This hay, so cut before blossoming, has kept a team of working stone-horses, round the year, fat without corn, who, when tried with beans and oats mixed with chaff, refused it for hay. The same fattened some sheep in the winter, in a pen with only it and water; they thrived faster than other sheep at the same time fed with pease and oats. The hay was weighed to them, and the clear profit amounted to four pound per ton. They made no waste, though the stalks were of an extraordinary bigness, they would break off short, being very brittle; this grew on rich ground, in Oxfordshire.

This was also an advantage to this hay; for apothecaries find that herbs dried in the shade retain much more of their virtue than those dried in the sun; but farmers not having any such conveniency of drying their hay in the shade with safety, must always choose to dry it by the sun; because in cloudy weather there is danger of rain, and therefore such excellent hay must be had by chance; for to be well made in the shade it must be in danger of being spoiled or damaged by rain.

The other part of the ground was afterwards cut in the prime of its flower, and made into hay by the heat of the sun, without rain or mist; this came out of the ricks at winter with a much finer colour, and as fine a smell as the virgin hay, but did not come near it in fattening sheep, or keeping horses fat at hard work, without any corn, as the virgin hay did.

This superfine hay cannot well be had of poor uncultivated* St.-Foin; because that may not be much above a handful high, when it is in condition to be so cut, and would then make a very light crop, and would be a great while ere it sprang up again; but the rich will have two or three tons to an acre, and spring again immediately for a second crop; so that little or nothing would be lost by so great an improvement of its quality. For hoed St.-Foin, upon a poor, chalky hill, cut at the same time with that uncultivated on a rich valley, does in dry weather grow again without delay, when the valley attends a month or more for a rain, to excite its vegetative motion.

This hay the owner (if he be wise) will not sell at any common price, but endeavour to have some of it every year, if possible, for his own use.

The second sort of St.-Foin hay is that cut in the flower, and though much inferior to the virgin hay, it far exceeds

* I reckon manure of peat-ashes, soot, or the like, to be a culture.

any other kind, as yet commonly propagated in England; and if it be a full crop, by good culture, may amount to above three tons on an acre. This is that St.-Foin which is most commonly made, and the larger it is, the more nourishing for horses. I have known farmers, after full experience, go three miles to fetch the largest stalky St.-Foin, when they could have bought the small, fine, leafy sort of it, at home, for the same price by the ton.

The next and last sort of St.-Foin that is cut only for hay is the full grown, the blossoms being gone, or going off; this also is good hay, though it fall short by many degrees of the other two sorts; it makes a greater crop than either of them because it grows to its full bulk, and shrinks little in drying.

This gives the owner a third chance of having weather to make good hay, and spins out the hay-season till about Midsummer; and then in about a fortnight or three weeks after the hay is finished, the seed is ripe. But first of the manner of making St.-Foin hay.

In a day or two after St.-Foin is mowed, it will, in good weather, be dry on the upper side; then turn the swarths, not singly, but two-and-two together; for by thus turning them in pairs, there is a double space of ground betwixt pair and pair which needs but once raking; whereas if the swarths were turned singly, that is, all the same way, suppose to the east or west, then all the ground will require to be twice raked, at least more of it than the other way.

As soon as both sides of the swarths are dry from rain and dew, make them up into little cocks the same day they are turned, if conveniently you can; for when it is in cock, a less part of it will be exposed to the injuries of the night than when in swarth.

Dew being of a nitrous, penetrating nature, enters the pores of those plants it reaches, and during the night possesses the room from whence some part of the juices is dried

out; thus it intimately mixes with the remaining sap, and when the dew is again exhaled, it carries up most of the vegetable spirits along with it, which might have been there fixed, had they not been taken away in that subtle vehicle.

If St.-Foin be spread very thin upon the ground, and so remain for a week in hot weather, the sun and dew will exhaust all its juices, and leave it no more virtue than is in straw.

Therefore it is best to keep as much of our hay as we can from being exposed to the dews, whilst it is making; and we have a better opportunity of doing it in this than in natural hay; because the bigger the cocks are, the less superficies (in proportion to the quantity they contain) will be exposed to the dew; and St.-Foin may be safely made in much larger cocks than natural hay of equal dryness can, which sinking down closer excludes the air so necessary for keeping it sweet, that if the weather prevents its being frequently moved and opened, it will ferment, look yellow, and be spoiled; against this misfortune there is no remedy, but to keep it in the lesser cocks until thoroughly dry. St.-Foin cocks, (twice as big as cocks of natural hay,) by the less flexibility of the stalks admitting the air, will remain longer without fermenting.

This being able to endure more days unmoved, is also an advantage upon another account besides the weather; for though, in other countries, people are not prohibited using the necessary labour on all days for preserving their hay, even where the certainer weather makes it less necessary than here, yet it is otherwise in England; where many a thousand load of natural hay is spoiled by that prohibition for want of being opened; and often by the loss of one day's work the farmer loses his charges and year's rent, which shows that to make hay while the sun shines, is an exotic proverb against English laws, whereunto St.-Foin being in regard of Sundays

and holidays more conformable, ought to be the hay as proper to England as those laws are.

But to return to our hay-makers. When the first cocks have stood one night, if nothing hinder, let them double, triple, or quadruple the cocks, according as all circumstances require, in this manner, viz., spread two, three, or more together in a fresh place; and after an hour or two turn them, and make that number up into one cock; but when the weather is doubtful, let not the cocks be thrown or spread, but enlarge them, by shaking several of them into one; and thus hollowing them to let in the air, continue increasing their bulk, and diminishing their number daily, until they be sufficiently dry to be carried to the rick.

This I have found the most secure way, though it be something longer in making, there is much less danger than when a great quantity of hay is spread at once; for then a sudden shower will do more harm to one acre of that, than to twenty acres in cock.

And the very best hay I ever knew in England was of St.-Foin made without ever spreading, or the sun's shining on it. This way, though it be longer ere finished, is done with less labour than the other.

Not only a little rain, but even a mist will turn clover-hay black: but St.-Foin will not with any weather turn black until it be almost rotten, its leaves being thinner than those of clover.

If St.-Foin be laid up pretty green it will take no damage, provided it be set in small round ricks, with a large basket drawn up the middle of each, to leave a vent-hole there through which the superfluous moisture of the hay transpires. But not to be afterwards made into large ones, as Equivocus directs.

As soon as its heating is over, these ricks ought to be thatched; and all St.-Foin ricks, that are made when the hay is

full dried in the cocks, ought to be thatched immediately after making them.

That which is laid up most dried, will come out of the rick of a green colour; that which has much heated in the rick will have a brown colour.

The seed is the fourth chance the owner has to make profit of his St.-Foin. But this, if the hoeing husbandry were general, would not be vendible in great quantities for planting; because an ordinary crop of an acre will produce seed enough to drill a hundred acres, which would not want replanting in a long time.

The other use then of this seed is for provender, and it has been affirmed by some who have made trials of it, that three bushels of good St.-Foin seed, given to horses, will nourish them as much as four bushels of oats. When well ordered, it is so sweet that most sorts of cattle are greedy of it. I never knew so much of it given to hogs as to make them become fat bacon; but I have known hogs made very good pork with it, for an experiment; and being valued at the beginning of their feeding, and the pork by the score when the hogs were killed, which, computed with the quantity of seed they eat, did not amount to near the value of the same seed sold for sowing; that being three shillings per bushel, and the profit made by giving it to the hogs was but two shillings a bushel.

The goodness of the seed, and of the hay out of which it is thrashed depends very much upon the manner of ordering them.

This thrashed hay, when not damaged by wet weather, has been found more nourishing to horses than coarse water-meadow hay; and when it is cut small by an engine, is good food for cattle, and much better than chaff of corn.

It requires some experience in it, to know the most proper degree of ripeness at which the seeded St.-Foin ought to be cut;

for the seed is never all ripe together, some ears blossom before others; every ear begins blossoming at the lower part of it, and so continues gradually to do upward, for many days: and before the flower is gone off the top, the bottom of the ear has almost filled the seeds that grow there; so that if we should defer cutting until the top seeds are quite ripe, the lower, which are the best, would shed and be lost.

The best time to cut, is when the greatest part of the seed is well filled; the first blown ripe, and the last blown beginning to be full.

The natural colour of the kernel, which is the real seed, is grey or bluish, when ripe; and the husk which contains the seed is, when ripe, of a brownish colour. Both husk and seed continue perfectly green for some time after full grown; and if you open the husk, the seed will appear exactly like a green pea when gathered to boil, and will, like that, easily be split into two parts. Yet St.-Foin seed in this green plight will ripen after cutting, have as fine a colour, and be as good in all respects, as that which was ripe before cutting. Some, for want of observing this, have suffered their seed to stand so long till it was all ripe and lost in cutting.

St.-Foin seed should not be cut in the heat of the day, whilst the sun shines out; for then much, even of the unripe seed, will shed in mowing. Therefore, in very hot weather, the mowers should begin to work very early in the morning, or rather in the night; and when they perceive the seed to shatter, leave off, and rest till towards the evening.

After cutting we must observe the same rule as in mowing it, viz., not to make this hay whilst the sun shines.

Sometimes it may, if the seed be pretty ripe, be cocked immediately, after the scythe; or if the swarths must be turned, let it be done whilst they are moist; not two together, as in the other hay aforementioned. If the swarths be turned with the rake's handle, it is best to raise up the ear-sides first, and

let the stub-side rest on the ground in turning; but if it be done by the rake's teeth, then let them take hold on the stub-side, the ears bearing on the earth in turning over. But it is commonly rain that occasions the swarths to want turning.*

If it be crooked at all, † the sooner it is made into cocks the better; because if the swarths be dry, much of the seed will be lost in separating them, the ears being entangled together. When moist, the seed sticks fast to the ear, but when dry, will drop out with the least touch or shaking.

There are two ways of thrashing it, the one in the field, the other in the barn; the first cannot be done but in very fine weather and whilst the sun shines, in the heat of the day; the best manner of this is to have a large sheet pegged down to the ground, for two men with their flails to trash on; two persons carry a small sheet by its corners, and lay it down close to a large cock and with two sticks thrust under the bottom of it, gently turn it over, or lift it up upon the sheet, and carry and throw it on the great sheet to the thrashers; but when the cocks are small, they carry several at once, thrown upon the little sheet carefully with forks; those which are near they carry to the thrashers with the forks only. As fast as it is thrashed, one person stands to take away the hay, and lay it into a heap; and sometimes a boy stands upon it, to make into a small rick of about a load. As often as the great

* If the swarths be not very great we never turn them at all; because the sun or wind will quickly dry them.

† Sometimes when we design to thrash in the field we make no cocks at all, and but only just separate the swarths in the dew of the morning, dividing them into parts of about two feet in each part. By this means the St.-Foin is sooner dried than when it lies thicker, as it must do if made into cocks.

This being done in the dew, prevents the damage of rubbing out the seed, which would be unavoidable if the swarths should be separated when dry.

sheet is full, they riddle it through a large sieve to separate the seed and chaff from the broken stalks, and put it into sacks to be carried into the barn to be winnowed.

Two thrashers will employ two of these little sheets, and four persons in bringing to them; and when the cocks are thrashed, which stand at a considerable distance all round them, they remove the thrashing-sheet to another place. There belong to a set for one thrashing-sheet seven or eight persons, but the number of sheets should be according to the quantity to be thus thrashed; the sooner these thrashed cocks are removed and made into bigger ricks the better; and unless they be thatched, the rain will run a great way into them and spoil the hay; but they may be thatched with the hay itself, if there be not straw convenient for it.

But the chiefest care yet remains, and that is to cure the seed; if that be neglected it will be of little or no value, and the better it has escaped the wet in the field, the sooner its own spirits will spoil it in the barn or granary. I have known it lie a fortnight in swarth, until the wet weather has turned the husks quite black; this was thrashed in the field, and immediately put into large vessels holding about twenty bushels each. It had, by being often wet and often dry, been so exhausted of its fiery spirits, that it remained cool in the vessels, without ever fermenting in the least, until the next spring, and then it grew as well as ever any did that was planted.

But there is yet another care to be taken of St.-Foin seed besides the curing it; and that is, to keep it from rats and mice after it is cured, else, if their number be large, they will in a winter eat up all the seed of a considerable quantity, leaving only empty husks, which to the eye appear the same as when the seeds are in them. A man cannot without difficulty take a seed out of its husk; but the vermin are so dexterous at it, that they will eat the seed almost as fast out

of the husks, as if they were pulled out for them. I saw a rat killed as he was running from a heap of it, that had seven peeled seeds in his mouth not swallowed, which is a sign that he was not long in taking them out. They take them out so cleverly, that the hole in the husk shuts itself up when the seed is out of it. But if you rub the husk between your finger and thumb, you will find it empty. Also a sackful of them is very light, yet there have been some so ignorant and incurious as to sow such empty husks for several years successively, and none coming up, they concluded their land to be improper for St.-Foin.

But of seed thrashed in the field without ever being wetted, if it be immediately winnowed, and a single bushel laid in a heap, or put into a sack, it will in a few days ferment to such a degree, that the greater part of it will lose its vegetative quality; the larger the heap the worse; during the fermentation it will be very hot and smell sour.

Many to prevent this spread it upon a malt-floor, turning it often; or when the quantity is small, upon a barn-floor; but still I find that this way a great deal of it is spoiled, for it will heat though it be spread but a handful thick, and they never spread it thinner; besides they may miss some hours of the right times of turning it, for it must be done very often; it should be stirred in the night as well as the day, until the heating be over; and yet do what they can, it never will keep its colour so bright as that which is well housed, well dried, and thrashed in the winter; for in the barn the stalks keep it hollow; there are few ears or seeds that touch one another, and the spirits have room to fly off by degrees, the air entering to receive them.

The only way I have found to imitate and equal this, is to winnow it from the sheet, then lay a layer of wheat-straw (or if that be wanting, of very dry thrashed hay), then spread thereon a thin layer of seed, and thus *stratum super stratum*,

six or seven feet high, and as much in breadth; then begin another stack, let there be straw enough, and do not tread on the stacks; by this means the seed mixing with the straw, will be kept cool, and come out in the spring with as green a colour as when it was put in, and not one seed of a thousand will fail to grow when planted. A little barn-room will contain a great quantity in this manner.

I have had above one hundred quarters of clean seed thus managed in one bay of a small barn. We do not stay to winnow it clean before we lay it up in the straw, but only pass it through a large sieve, and with the van blow out the chaff, and winnow it clean in the spring.

This field-thrashing requires extraordinary fine sun-shiny weather, which some summers do not afford at the season, for thrashing a great quantity of it; for it is but a small part of the day in which the seed can be thrashed clean out. They who have a small quantity of it, do carry it into a barn early in the morning, or even in the night, whilst the dew is on it, for then the seed sticks fast to the ear; as it dries they thrash it out, and if they cure it well, have thus sometimes good seed, but generally the hay is spoiled.

There is one method of saving all the seed good, and the hay too, by carrying it unthrashed to the barn or rick in a particular manner, though it be a great quantity, more than can presently be thrashed; but must be laid up in mows or ricks as corn is. Then if it be carried in, in the dews or damp, the hay is sure to be spoiled, if not both hay and seed; when it is taken up dry, the seed comes out with a touch, and the greatest part is lost in pitching up the cocks, binding, and jolting in carrying home.

To avoid this dilemma, a person who happened to have a great crop of seed on one hundred and fifty acres together (and being by weather delayed until wheat-harvest came on, so that most labourers went to reaping), was forced to a con-

trivance of getting it in as follows, viz., three wagons had each a board with a hole in, fixed across the middle of each wagon by iron pins, to the top of the rades or sides; there was a crane which a man could lift, and set into the hole in the board, and having an iron-gudgeon at the bottom, which went into a socket in the bottom of the wagon, would turn quite round; the post of the crane was ten feet four inches long, its arm four feet eight inches long, braced, having a triple pulley at the end of it, and another to answer it with a hook.

About forty sheets were provided capable of holding each one hundred and fifty or two hundred pounds weight of it; these had knots or buttons at the corners and middles, made by sewing up a little hay in these knots as big as apples into part of the sheet; for if any buckle or other thing be sewed to a sheet plain, it will tear the sheet. Half these buttons have strings tied to them, these sheets are spread among the cocks, filled by two and tied up by two other persons; there is also a light fir ladder wide at bottom, the top of it fastened by a piece of cord to the brace of the crane, they hitch the hook of the lower pulley to a filled sheet, and by a little horse at the end of the pulley-rope, draw it up sliding on the ladder; it is up in a moment: then the man who is below, hitches the crook of the pulley to the lower round of the ladder, and the loader above pulls up the ladder from the ground, till the wagon comes to another sheet. The wagons are lengthened by cart-ladders before and behind, for the more easy placing of the sheets. When about twelve or fifteen of them are loaded, they have a rope fixed to the forepart of each wagon, which they bring over the top of all the loaded sheets, and rest it at the tail, to hold on the sheets fast from falling off with jolting. Then the loader pulls out the crane, and puts it into the next wagon in the same manner. One wagon is loading whilst another is emptying

in the barn by triple pulleys likewise; because it is inconvenient to take it out of the sheets by prongs, but the pulleys will easily draw off two or three sheets together. One wagon is always going to the field or coming home. This contrivance makes more expedition than one would imagine: three loads have been loaded and sent off in the same time this way, that one load of hay has been loading, binding, and raking off the outsides of it, in the next ground, in the common way.

I will not relate the manner of making a rick of this seed in its hay of monstrous dimensions, by a sort of mast-pole forty-four feet high, with a ten-foot crane at the top, which made the same expedition; because I think, that where such a quantity is, Dutch barns with moving roofs are better. Such a rick is troublesome to thatch, and the wind has more power to blow the thatch off so high in the air than if it were lower. Neither would I advise any one to reserve much more St.-Foin for thrashing, than this barn will contain; because though sometimes it brings the greatest profit by thrashing, yet some years it is apt to be blighted.

I have been told by my neighbour, that he had a crop of five quarters of St.-Foin seed on an acre; but the most profit that ever I took notice of, was on half an acre, which was drilled very thin, and had no crop of corn with it; by which advantage it produced a good crop of seed the next year after it was planted, and the third year this half-acre produced (as was tried by a wager) within a trifle of two quarters of seed, which was sold for two pounds and ten shillings; the thrashed hay of it was sold in the place for one pound, and two quarters of chaff sold for twelve shillings; in all, four pounds and two shillings. There was also a very good aftermath, which was worth the charges of cutting and thrashing: so that the clear profit of the one year of this half-acre of ground, amounted to four pounds two shillings;

and it was remarkable, that at the same time the rest of the same field, being in all ten acres, had a crop of barley sown on three ploughings, which (the summer being dry) was offered to be sold at one pound per acre.

I believe the greatest part of the St.-Foin that is sown is spoiled by being indiscreetly fed by sheep*; which damage is occasioned merely by suffering them to continue feeding it too long at a time, especially in the spring, for then the sap moves quick, and must be depurated by the leaves; and as the sun's nearer approach accelerates the motion or ferment of the juices, more *pabulum* is received by the roots; but for want of leaves to discharge the recrements, and enliven the sap with nitro-aërious particles (the sheep devouring the buds continually as fast as they appear), the St.-Foin's vital flame (if I may so call it) is extinguished; the circulation ceasing, the sap stagnates, and then it ends in corruption†. But let the sheep eat it never so low in a short time, without continuing thereon, or cropping the next buds which succeed those they have eaten, the plants will recover and grow again as vigorously as ever; and if, with a spade in the winter, you cut off the St.-Foin heads an handful deep, and take them away, together with their upper earth, the wound in the remaining root will heal, and send out more heads as good as those cut off, if those second

* I never suffer sheep to come upon St.-Foin, except betwixt mowing-time and All-Saints. And there is so much danger of spoiling St.-Foin by the fraud of shepherds, that I knew a gentleman that bound his tenant never to suffer any sheep to come thereon; and by this means his St.-Foin continued in perfection much longer than is usual, where St.-Foin is suffered to be fed by sheep.

† Natural grass is not killed by constant feeding, because no sort of cattle can bite it so low as to deprive it of all its leaves; and it is like eels, more tenacious of life than the rest of its genus, and will send out leaves from the very roots when reversed, as is too often seen where turfy land is ploughed up in large furrows.

heads be preserved from cattle, until they attain to a bigness competent to bear leaves sufficient for the use of the reviving plants; nay, I have seen plants of St.-Foin cut off in the winter a foot deep, and the earth of that depth taken away, and the remaining root recovered and grew to an extraordinary bigness, but this was preserved from cattle at first.

I esteem St.-Foin to be much more profitable than clover, because St.-Foin is never known to do any perceivable damage to the corn amongst which it is planted, but clover often spoils a crop of barley; and I have known that the crop of barley has been valued to have suffered four pounds per acre damage, by a crop of broad clover growing in it in a wet summer; in a dry summer both sorts of clover are apt to miss growing, and if it does grow, and the next summer (wherein it ought to be a crop) prove very dry, it fails on most sorts of land, though it was vigorous enough to spoil the barley the year it was sown; at best it is of but very short duration, and therefore is not to be depended on by the farmer, for maintaining his cattle, which the broad clover will also kill, sometimes by causing them to swell, unless great care be taken to prevent it. The broad clover is esteemed a foul feed for horses. The hop clover is gone out of the ground sooner than the broad clover; I never knew it cut more than once: indeed cattle are never swollen by feeding on it; but then it affords but very little feeding for them, except the land whereon it grows be very rich.

But this damage may be prevented by drilling the clover after the barley is a handful high or more; for then the barley will keep it under, and not suffer it to grow to any considerable bigness till after harvest, nor will this drill, being drawn by hand, do any damage to the barley.

St.-Foin is observed to enrich whatever ground it is planted on, though a crop be taken off it yearly.

Poor slate land*, when it has borne sown St.-Foin for six or seven years, being ploughed up and well tilled, produces three crops of corn, and then they sow it with St.-Foin again.

Rich, arable land was planted with it, and mowed annually with very great crops (it was drilled in nine-inch rows, with six gallons of seed to an acre; one crop of it was sold at four pound per acre); this, after about seven years, and in full perfection, was ploughed up by a tenant, and continued for many years after so rich, that instead of dunging or fallowing it for wheat, they were forced to sow that upon barley-stubble, and to feed the wheat with sheep in the spring, to prevent its being too luxuriant.

But it is to be noted, that the land must be well tilled at the breaking up of old St.-Foin, or else the first crops of corn may be expected to fail. For I knew a tenant, who, the last year of his term, ploughed up a field of St.-Foin that would have yielded him three pounds per acre; but thinking to make more profit of it by corn, he sowed it with white oats upon once ploughing, and it proving a dry summer, he lost his ploughing and seed; for he had no crop of oats, and was forced to leave the land as a fallow to his successor.

Many more instances there are of this failure of the crop of corn after St.-Foin has been broke up, and not well tilled.

When St.-Foin is grown old and worn out, as it is said to be when the artificial pasture is gone, and the natural pasture is become insufficient for the number of plants that are

* The poverty of this sort of land, lying upon slate or stone, generally proceeds from the thinness of it, and if it were thicker it would be good land; much of this earth being dispersed among the crannies or interstices of the slate and stone to a great depth, is reached by the tap-roots of the St.-Foin, but cannot be reached by the roots of corn; and therefore when constantly kept in tillage is of small value, upon which account such land is greatly improvable by St.-Foin, even when sown in the common manner.

on it to be maintained, and is so poor that it produces no profitable crop, so that the ground is thought proper to be ploughed up and sown with corn, in order to be replanted*; the most effectual way to bring it into tilth speedily, is to plough it up in the winter with a four-coultered plough, and make it fit for turnips by the following season; and if the turnips be well hoed, and especially if spent by sheep on the ground, it will be in excellent order to be sown with barley the following spring, and then it may be drilled with St.-Foin amongst the barley.

To return to the benefit land receives by having been planted some years with St.-Foin. All the experienced know that land is enriched by it, but they do not agree upon the reason why.

They agree as to the Ὅτι, but not the Διότι.

Some are of opinion it is because the St.-Foin takes a different sort of nourishment to that of corn: but that I think is disproved in Chapter "Of Change of Species," where it is shown that all plants in the same soil must take the same food.

Mr. Kirkham thinks St.-Foin has no collateral or hori-

* Or if you perceive that there is a competent number of plants alive, and tolerably single, be they never so poor, you may recover them to a flourishing condition in the following manner, without replanting: Pulverise the whole field in intervals of about three feet each, leaving betwixt every two of them four feet breadth of ground unploughed, when the turf of these intervals being cut by the four-coultered plough is perfectly rotten. One furrow made by any sort of plough will hoe one of these intervals, by changing the whole surface of it. The poorer the land is the more hoeings will be required, and the oftener it is hoed, with proper intermissions the first year, the stronger the St.-Foin will become, and the more years it will continue good, without a repetition of hoeing.

The expense of this cannot be great; because the plough, in hoeing an acre in this manner nine times, travels no further than it must to plough an acre once in the common manner.

I need not tell the owner that the earth of these intervals must be made level before the St.-Foin can be mowed.

zontal roots in the upper part of the ground where the plough tills for corn, and, therefore, has no nourishment from that part of the soil which feeds the corn. This would be a very good account for it, were it not utterly contrary to matter of fact, as every one may see.

But so far it is right, that large* St.-Foin draws the greatest part of its nourishment from below the reach of the plough; and what part it does receive from the staple is overbalanced by the second crop or after-lease, being spent by cattle on the ground; different from corn, which is very near wholly maintained by the ploughed part of the earth, and is all carried off.

For though the under stratum of earth be much poorer than the upper, yet that never having been drained by any sort of vegetables, must afford considerable nourishment to the first that comes there.

And, besides, in such land whose poverty proceeds from the rain carrying its riches too quickly down through the upper stratum, the under stratum must be the richer† for receiving what the upper stratum lets pass unarrested.

It is well known that many estates have been much improved by St.-Foin; therefore there is no occasion to mention particulars. Only I will take notice that the first in England was one of about one hundred and forty pounds per annum, sown with St.-Foin, and sold for fourteen thousand pounds; and, as I hear, continues, by the same improvement,

* For large St.-Foin being single has large roots and very long, which probably descend twenty feet deep. Now if we allow four or five inches the depth of the staple, to afford a supply equal to two feet below it, taking the lower nineteen feet seven inches together, upon this computation, the part below the staple gives the St.-Foin about nine parts in ten of its sustenance.

† In light poor land, the water carrying some impregnated earth along with it down lower than it does in strong land, that is more tenacious of such impregnated particles, the under strata of strong land are likely to be poorer than those of light land.

still of the same value. This is I suppose the same that Mr. Kirkham mentions in Oxfordshire.

Another farm of ten pounds per annum rent, which whilst in arable* was like to have undone the tenant, but being all planted with St.-Foin by the owner, was let at one hundred and ten pounds per annum, and proved a good bargain.

If it should be asked, why St.-Foin is an improvement so much greater in England than in other countries; it might be answered by showing the reason why English arable is of so much less value than foreign, where the land is of equal goodness, and the corn produced of equal price.

It is doubtless from the extraordinary price of English labour above that of other countries, occasioned by English statutes being in this respect different from all other laws in the world.

* These estates consisted of thin slaty land; which, before it was planted with St.-Foin, was valued at two shillings per acre, and some part of it at one shilling per acre (as I have been informed), and yet oxen are well fatted by the St.-Foin it produces.

CHAPTER XV.

OF LUCERNE.

LA LUCERNE is that famous *herba medica* so much extolled by the ancients.

The high esteem they had of its use appears by the extraordinary pains they bestowed on its culture.

Its leaves resemble those of trefoil; it bears a blue blossom very like to double violets, leaving a pod like a screw, which contains the seeds about the bigness of broad clover, though longer and more of the kidney shape.

The stalks grow more perpendicular than any of the other artificial grasses that I know, slender, full of knots and leaves; it is of very near an equal bigness from bottom to top. When cut, if vigorous, the stalks will spring out again from the stubs, immediately below where the scythe parted them, which makes them the sooner ready for another mowing; an advantage which no other grass has.

It has a tap-root, that penetrates deeper into the bowels of the earth than any other vegetable she produces.

Though one Lucerne root be much more taper than another towards the upper part of it, it is sometimes seen that a single hoed plant of it has many of these perpendicular roots, some of them springing out from the very branches of its crown.

Its roots are abundantly longer than the roots of St.-Foin; I have one that measures very near two inches diameter; those which are higher than the ground have a bark like a tree. Upon this account, and by its stalks springing again just below the place where cut off, and by the woody hard-

ness of its stalks, when they stand too long without cutting, it seems that Lucerne is of a nature nearly approaching to that of a shrub.

Lucerne is the only hay in the world that can pretend to excel or equal St.-Foin. I have known instances of the pin-guifying virtue of this *medica* hay, that came up to the highest encomiums given it by the Romans ; which being to the vulgar incredible, I forbear to relate, but leave to be confirmed by the experience of others, when it becomes frequent in England.

Lucerne in grass is much sweeter than St.-Foin, or any other artificial or natural grass. This when hoed may be given to cattle, cut green, for six months ; but then care must be taken to prevent their swelling by its lusciousness, and not to give them too much at once, until they be accustomed to it.

The swelling of cattle, by eating too much green Lucerne, clover, or turnip-leaves, happens only to such as chew the cud, because they swallow more in less time than other cattle do ; and a large quantity of such luscious greens being swallowed by a beast, fermenting to a great degree, heats and rarefies the internal air, which by its spring becoming too strong for that column of the atmosphere that enters at the trachea, it presses the lungs against the *thorax* so closely, that the weight of the external column is not of force to open their vesicles, and then the circulation of the blood is stopped, and the beast is strangled.

Most farmers know how to prevent the swelling, so that now-a-days it seldom happens ; but when it does, there is an effectual way of curing it, if taken in time. They cut a hole into the maw near the back, in a proper manner, whereat the rarefied air rushes out, and the lungs again perform their action of respiration.

But that any sort of good dry hay, whether made of

Lucerne or any other grass, would cause this misfortune of swelling, I never heard was said by any body except Equivocus; and he appearing to be a person of no veracity, I have no reason to believe it from his assertion.

The quantities of Lucerne-seed annually imported, and sown without success, not discouraging people from continuing its importation, shows there is more need of a successful way of planting, than recommending it in England.

I shall take notice of some of the reasons why I conclude there is no hope of making any improvement by planting it in England, in any manner practised by the ancients or moderns.

I wonder how any one should attempt to plant it here, who has seen in Columella and other authors, the description of the manner the old Romans planted it in. They chose out the very best land, that was both *pinguis* and *putris*; they dunged and tilled it to the greatest perfection, and laid it out in beds, as we do for onions or asparagus; they sowed it very thick, for that miserable reason of enabling it by its thickness the better to kill the grass. The beds being harrowed very fine before sowing, which was in the end of April, the seed required to be speedily covered, lest the sun's heat should spoil it. But with what instrument must it be covered? For after sowing, the place must not be touched with iron. *At medica obruitur non aratro, sed ligneis rastellis.* *Medica* seed is covered, not with the plough, but with little (or rather light) wooden harrows. Two days' work (of a team) were spent on this harrowing of one acre. Some time after it came up, they scratched it again and again with the same wooden instruments, this was called *sarrition*; then by *runcation* they weeded it over and over, *Ne alterius generis herba invalidam medicam perimat.* Lest other grass should kill it whilst it was weak. The first crop they let stand till some of the seed shattered, to fill the ground yet fuller of

plants; after that they might cut it as young as they pleased; but must be sure to water it often after cutting. Then after a few days when it began to spring, they repeated their runcation, and so continuing to weed out all manner of grass for the first two or three years, it used to bring four or six crops a year, and last ten years.

English gardeners make forty pounds of an acre of asparagus, or cabbage-plants, with half the labour and expense that was bestowed on an acre of Roman medica.

We know not the price hay and grass were at in Italy, whilst the Roman empire was in its glory, and Rome then the metropolis of the world, drew the richest of all parts thither; its price must be then very high.

And the Romans had not only servants, but plenty of slaves, for whom they had scarce sufficient employment; this might lessen the expense of this tedious method of planting, and ordering the medica. But when the Romans were brought down to the level of other nations, and in danger of being slaves, instead of having them; and the lands of Italy came to be cultivated by Italian hands only, they found something else more necessary to employ them in, than the sarritions, runcations, and rigations of the medica. Their labour being bestowed in getting bread for themselves, they substituted other artificial grasses of more easy culture, in the room of medica, for the food of their cattle. They were so bigoted to all the superstitions of their ancestors, that they were content to lose the use of that most beneficial plant, rather than attempt to cultivate it by a new, though more rational, method, when they were become unable any longer to continue it by the old.

Thus, as I take it, superstition has chased medica from the Roman territories, and so little of it is planted there, that beyond the Alps I could not find one whole acre of it.

Lucerne makes a great improvement in the South of

France; there, when their low sandy land is well prepared, and very clean, they sow it alone, in March and Michaelmas, as we do clover. Their sowing it at those seasons is of a double advantage. First, it saves the labour of watering it, which would be impracticable for so many thousand acres as are there planted. Secondly, those seasons being much moister than that wherein the Romans sowed it, the grub has opportunity of eating more of it at its first coming up; and often the frost kills some of it. By these advantages the ground is less overstocked.

The summers there are much drier than in Italy, so that the sun scorches up the natural grass, and suffers it not to come to a turf until after some years; and therefore has less need of weeding.

But as that natural grass increases, the crops of Lucerne are proportionably diminished; and though Lucerne is said to last ten or twelve years, yet it is in perfection only for a very few years. Whilst it is at best, on their richest land, and in a kind summer, they have, at seven crops, ten tuns to an acre, as I have computed them from the relation of some of the inhabitants of Pezenas. This was extraordinary, for I observed that most of their common crops made a very thin swarth.

When the ground begins to be turfy and hard, many of the Lucerne plants die, and the rest send up very few stalks; the people know this is the destruction of it, and therefore I have seen some of them in that case, half plough it, thinking thereby to destroy the turf: this does for a time much strengthen the Lucerne plants, but it so much strengthens the grass also, that the turf grows the stronger, and then there is no remedy but to plough it up, make the ground clean, and replant it.

In more northern climates, where it rains oftener, the ground sooner becomes hard; and in the land otherwise

most proper for Lucerne, the grass grows infinitely faster, and will be as strong a turf in two years, as in the hot countries in ten. Upon this account, about Paris, even near the walls, they plough up Lucerne, and sow St.-Foin in its room; because that endures grass and hard ground better, though it brings but one crop a-year, or two at most.

And in many places in Franche Comté, and Switzerland, I have seen Lucerne in the corners of the vineyards, not above two or three perches together, which they will at any expense have, to cure their horses when sick; since they cannot obtain by their culture quantities sufficient to maintain them as their ordinary food, there being too much rain, and too little of the sun's violent heat, to prevent the speedy increase of grass amongst it.

How then can we expect success in sowing it in England, where rains are yet more frequent, and the sun is weaker? It is not one year in ten that the natural grass is here scorched up. In our rich land the grass comes to a turf very soon, and poor land will not by the common sowing bring Lucerne to any perfection, though no grass should annoy it.

I have here seen part of a meadow breast-ploughed, and when the turf was dead, dug up and planted as a garden; after it had been drilled with carrots, hoed, and made in all appearance perfectly clean, it was sown with Lucerne, which came up and flourished very well the first year, and indifferently the second; but after that, the grass came and the Lucerne grew faint, and in three or four years' time there was no more left, but just to show by here and there a single poor stalk, that there had been Lucerne sown, except one plant of it, which was cleansed of grass the third year; and this recovered and sent up abundance of stalks for two years after it; and then the grass returning, that plant dwindled again.

I have often tried it in the richest part of my garden, and

constantly find, that however vigorously it grows at the first, yet it soon declines when the grass appears amongst it, which is always the sooner, by how much the soil (in England) is richer, unless the spade or hoe prevent it.

Here have been also many fields of a poorer, whitish soil sown with it, which are not very subject to be overrun with grass, as the rich land is; and though these were so well tilled as scarce any grass appeared, during the many years the Lucerne lived therein, yet it never grew to any perfection here neither; nor was there any one crop worth much more than the cutting, it was always so poor, thin, and short. And by what intelligence I can get, all experience proves, that every soil in this island is too rich, too poor, or too cold for the Lucerne improvement by the common husbandry.

I believe every one will be confirmed in this, who shall upon full inquiry find that, amongst the great quantities which have been sown in this kingdom in that manner, never any of it was known to continue good and flourishing three years. And that, on the contrary, never any one plant of it in any warm soil, cultivated by the hoeing manner, was known to fail here, or in any other country, as long as the hoeing (or digging about it, which is equivalent) was continued to it with proper repetitions.

A multitude of such hoed plants have I known, and are now to be seen in both poor and rich lands; therefore it seems possible that thousands of English acres may be capable by the hoeing culture, to produce crops of Lucerne every year for an age. For as the greater moisture and less intense heat of this climate are, upon the accounts mentioned, injurious to Lucerne, yet this is only to such as is sown and cultivated in the common manner, because our climate upon the very same accounts is very advantageous to hoed Lucerne. In hot countries, when the summer is drier than ordinary, the sun so scorches it, that they have fewer and much poorer

crops than in moister summers, viz., only four or five instead of six or seven; but in the driest summer I ever knew in England, hoed Lucerne yielded the most crops.

Our summer days are longer, have more of the sun's warmth, and less of his fiery heat; he cherishes but never burns Lucerne, or any other hoed, long, tap-rooted plant in England.

The well-hoed earth being open, receives and retains the dews; the benign solar influence is sufficient to put them in motion, but not to exhale them from thence. The hoe prevents the turf, which would otherwise by its blades or roots intercept and return back the dews into the atmosphere, with the assistance of a moderate heat. So that this husbandry secures Lucerne from the injury of a wet summer, and also causes the rain water to sink down more speedily, and disperse its riches all the way of its passage, otherwise the water would be more apt to stand on the surface, chill the earth, and keep off the sun and air from drying it; for when the surface is dry and open, Lucerne will bear a very great degree of heat, or grow with a mean one: I have seen this hoed Lucerne, in a sheltry place of my garden, so much grown in a mild winter, as to be measured fourteen inches and a half high at Christmas; and a very large single plant of it, which had not been hoed for two years before, was laid bare by digging out the earth all round it a foot deep, to observe the manner of its tap-root, and then the earth was thrown in again, and the hole filled up. This was on the 27th of September. Upon this mellowing of the soil about it, it sent out more stalks in October than it had done in the whole summer before; they grew very vigorously, until a great snow fell in December, which also preserved the verdure of them, until that was melted away, and a black frost came after it, and killed those stalks. It is probable this plant sent out immediately new fibrous horizontal roots,

which did grow apace to extract the nourishment from this new-made pasture, in proportion to the quick growth of the stalks, which in summer have been measured, and found to grow in height three inches and a half in a night and day; this being almost one inch in six hours.

And it has been my observation, that this plant in hot and cold countries thrives both with a much greater or less degree of heat and moisture when it is hoed; for if it has plenty of nourishment, which hoeing always gives it, a very little heat above, and the moisture alone (which is never wanting to the deep tap-root) suffice, and that plenty of food enables it the better to endure the extremes of either heat or cold.

We need not much apprehend the danger of English winters, for Lucerne will endure those which are more rigorous. In the principality of Neufchatel the winters are so severe, as to kill all the rosemary left abroad, yet Lucerne survives them there; this proves it more hardy than rosemary, which is planted for hedges in England, and here is scarce twice in an age a frost able to kill it.

I have one single Lucerne plant in a poor arable field, that has stood the test of two-and-twenty winters, besides the feeding of sheep at all seasons, and remains yet strong as ever. What quantity of hay this plant yearly produces cannot be known, because at those times that cattle are kept from it, the hares constantly crop it, being sweeter than any other grass.

But this happens to be fortunately situate, where it is not altogether destitute of the benefit of hoeing. It is in an angle, where, every time the field is tilled, the plough goes over it in turning from the furrows of one land and one head-land, but it is after the plough is lifted out of the ground and turned up on one side, so that the share only breaks the turf very small all round it, without ploughing up the plant; yet it has escaped it so narrowly, that the fin of the ploughshare has

split it into four parts, three of which remain and grow never the worse, but the fourth is torn off, and the wound healed up.

By the extreme hard winter that happened about the year 1708 or 1709, some of the Lucerne in Languedoc was killed ; yet this was no argument of its tenderness, but rather the contrary ; because then all the olive-trees and walnut-trees were there killed, though the greatest part of the Lucerne escaped unhurt ; and I did not hear one walnut-tree was killed that winter in England. Perhaps those in France, having been accustomed to much hotter summers, were unable to endure the rigour of the same winter, that could do no harm to the same species in England, where our winters do not seem to exceed some of theirs in cold, so much as their summers do ours in heat. And since the extremes are not so far asunder here, the same degree of cold may to our plants seem tepid, which to those in Languedoc must seem rigorous, differing in a more remote degree from the opposite extremity of heat in summer.

And besides the difference of heat and cold in different climates, there is another more necessary to be observed, and that is the difference of the hardiness in different individuals of the same species ; the same frost that kills a faint languishing plant of Lucerne, will be despised by a robust one, which being well fed by the hoe, becomes a giant clothed and fenced with a thick bark, that renders it impregnable against all weather ; its rind is to it a coat of mail or buff impenetrable by frost ; but the unhoed is generally small and weak, its thin, tender bark exposes it almost naked to the frost, it being for want of a sufficient pasture starved and half dead already, it is the more easily killed by the cold.

I formerly lived some years in Languedoc, where are many hundred acres of Lucerne ; and I never could find a very large plant amongst it, unless in such pieces as had been ploughed up, tilled and sown with corn ; here indeed those

plants that remained (as always some would do) grew to an extraordinary bulk ; and one of those single tilled plants did seem to produce a greater quantity of stalks than twenty of such as had not been ploughed up ; and as there were no large plants amongst the unploughed, so there were no small amongst the ploughed ones. The same thing has been observed in all other places where Lucerne has been ploughed. This ploughing is a hoeing to the Lucerne.

And in Wiltshire several grounds of it stood some years without ever coming to a substance to be of any value, though the land was whitish, and scarce any grass appeared amongst the Lucerne ; and therefore its poorness was thought to proceed from the soil being improper ; but when it had been broke up, and sown several years with corn, and afterwards lain down with St.-Foin, all the Lucerne plants which remained (and they were many) grew large and strong, snooting up a yard in height soon after the St.-Foin was cut ; and if there had been a competent number of them undestroyed by the plough, they would have yielded crops of an extraordinary value, where before ploughing it grew but few inches above the ground.

It seems that in this sort of land the earth grows stale, ere the Lucerne arrives at a tenth part of its stature ; but this is most remarkable, that tillage transforms those Lucerne-plants from dwarfs to giants ; and then they are able to contend with, if not conquer so strong plants as St.-Foin are, though before ploughing they were unable to resist the depredations of a few hairy spires of grass.

Since tillage can thus recover Lucerne, after it has long languished in the lowest ebb of life, and restore it to health, youth, and vigour, and augment its stature even after it has passed the age of its full growth, to what bulk would it arrive regularly planted, and hoed from its infancy to maturity, without any check to stunt it ?

We can never know how poor a soil will bear this plant, unless it be tried by the hoeing culture.

For it is wondrous how so great a man as Dr. Woodward should imagine, that difference of soil should be the reason why apples in Herefordshire, and cherries in Kent, succeed better than in other places, when in truth they are seen to prosper as well almost all over England, where planted, cultivated, and preserved.

This I suppose the Doctor took from Virgil's *quid quæque ferat regio, et quid quæque recuset*. For when the Roman soldiers had, as a reward of their rebellion, obtained the lands of their country from their lawful owners, their product would have disappointed all expectations of profit, if those lands should have been planted with ivory or frankincense. Sure the Doctor did not consider, how different the soil of these mentioned counties is, to that of those climates from whence apples and cherries were originally brought; it must be greater than between that of any two counties in England. The reason why no more of these large plantations are made, is probably for want of sufficient laws to secure their fruit to the owners.

I believe plants are more altered as to their growth, by being cultivated or not, than by change of climates differing in very many degrees of latitude. I say in their growth, not always in their fruit; for though a peach-tree well cultivated in a standard, will grow here vigorously, and be very beautiful, yet its fruit will be of little value, unless it be planted against a good wall; so Lucerne, unless cultivated upon a well exposed gravel, will yield little seed in England.

The soil to plant it on is either a hot gravel, a very rich, dry sand, or some other rich, warm land, that has not an under stratum of clay, nor is too near the springs of water; for if the earth below be of a cold nature, which I take to be occasioned by its holding of water, the Lucerne will not long prosper

therein, of whatever sort the upper stratum of earth may be: this may be guessed at by the vegetables a soil naturally produces, as fern and the like, which Mr. Evelyn observes do indicate a soil subject to extremities of heat and cold, and condemns such a soil as accursed. I agree to that sentence as relates to cold, but I am not satisfied of its abounding with heat, and I am sure I know some land very subject to fern, which is very far from being barren, when well cultivated and well suited with vegetables; but, from among these, Lucerne must be excluded.

Lucerne in hot countries grows best near rivers, where its roots reach the water, which helps to mitigate the excessive heat of the climate; but here the heats are so moderate, that if Lucerne roots are in water (for it is that makes earth cold) it diminishes too much the just proportion of heat which Lucerne requires.

The natural poorness of a hot gravel may be compensated by dung, more heat, and the benefit of the hoe.

The natural richness of the other sorts of land being increased by hoeing and cleansing it from grass, Lucerne will thrive therein with the less heat; for what the soil wants of one of these two qualities, must be made up with the other; and it has grown high in hoed, rich ground at Christmas, when that in land of a hotter nature, but poorer, has not been able to peep out, for want of more nourishment; so if rich land be clayey, very wet and cold, though very rich, it requires much heat, for as high a growth of Lucerne at Midsummer.

The best season of planting it in England I take to be early in spring; for then there is always moisture to make it grow, and not heat enough to dry its tender root, so as to kill it by malting it.

If they should take so early a season for the common way of sowing it, the ground would become hard or stale, before the sun were high enough to bring it forward; but there is no danger of

this inconvenience to that where the hoe is to come, and open the ground as often as there shall be occasion.

I have planted it at the end of February, and though there followed a very hard frost in March, which killed some part of it, yet what remained was of sufficient thickness, and I believe the quantity of seed planted might be after the rate of betwixt one and two pounds to an acre. The depth it was planted at was half an inch, which upon trials I found best for most sorts of fine seeds. I do not approve of planting it late in the autumn, because our long winter might kill too much of it, and weaken the rest in its tender infancy.

The hoed plants of Lucerne having larger roots, and yielding more crops than those of St.-Foin, reason seems to require that the number of the former be less.

But on the other hand, if we consider that as the Lucerne roots exceed the St.-Foin in bigness, so they also do in length, by as great a proportion, being generally less taper, and as they go deeper, they have more earth to nourish them. They also require a better soil, and more frequent aids from the hoe; and by their extraordinary quick growth, receive a speedier relief from it than the roots of St.-Foin do.

Thus, if by reaching deeper in a better soil, and being more hoed, Lucerne receives, from a square perch of ground, nourishment in a proportion double to that whereby its roots exceed those of the St.-Foin in bigness, then I do not see why we should not leave the number of Lucerne-plants double to the number of those we leave in St.-Foin.

But if the excess of nourishment were no more than the excess of bigness of roots, I think an equal number of plants should be left in Lucerne and in St.-Foin; yet, since the hot or cold constitution of a plant, and also the quantity it can produce, ought to be considered as well as its bulk, in relation to the nourishment it requires, more trials are necessary for determining the exact number of Lucerne-plants proper

to be placed on a square perch, than have been hitherto made.

Perhaps it will be thought heterodox to maintain any arguments that to err in falling somewhat short of the just number, is not of worse consequence than exceeding it.

Where they stand at four or five inches asunder in the rows, it is observed that though the intervals betwixt the rows be wide, yet the plants are much the larger, and produce more, that stand in the outside rows (the ground without being clean), and especially those at each end of the outside rows, that is, the corner plants are largest of all. I need not say, that had all the other plants as much room and tillage as the corner ones have, they would be as large, and produce each as much hay; for those which stand perfectly single, in places by themselves, are seen to be larger, and produce more than those corner ones; and of the larger and longer roots our stock doth consist, the more nourishment are they capable of taking, as has been shown.

And it must be likewise observed, that the crop will be produced in proportion to the nourishment it receives; for if the most gigantic Lucerne-plant, which, when pampered by the hoe, has made a produce more like a tree than an herb, remains a few years without that or some equivalent culture. it will by little and little cease to produce more than a few poor sickly stalks, just to show its species, and then, if this culture be repeated, it will recover its pristine strength, and yield as great a crop as ever; but if that be longer omitted will die; the vastness of its roots avails nothing, unless it has food in proportion to it.

Hence it appears, that the most fatal disease incident to Lucerne is starving, and that rarely suffers any of its plants to arrive at the full period of their growth or age; it prevents their fertility even in the prime of their youth, and kills them even before they have lived out half, or perhaps the tenth part

of their days; how long its life might otherwise be, nobody knows, unless a plant could be found to die when well fed; for when it is, it is so tenacious of life, that I am told beheading will not despatch it*.

It is therefore necessary that our rows be placed at such a distance, as that their intervals may be wide enough for the hoe-plough to raise an artificial pasture, sufficient to sustain the number of plants in them.

Whoever shall make trials of this husbandry (for that is all I propose to others) I would advise them to begin with rows that have intervals of thirty inches; for if they begin with much narrower distances, they may be by that means disappointed of success; but though they should afterwards find a way to hoe them at somewhat nearer distances, yet the loss of a few perches of ground would not be much, neither can they be wholly lost, since the roots of these plants may be proved to extend much farther horizontally, than from row to row at that distance. And the wider the intervals are, the more earth will be tilled in a perch of ground; because six rows, which will be therein at thirty-three inches distance, will admit the hoe-plough to till more earth than nine rows at twenty-two inches distance from each other: and besides, it is not proper that every time of hoeing, the plough should come very near to the plants, unless when grass comes amongst them; and then they may in thirty or thirty-three-inch spaces be perfectly cleansed in this manner, viz., plough a good furrow from each side of every row, and then with harrows or other instruments proper for that purpose, going across them, you will pull out both earth and grass from betwixt the plants; then, after a convenient time, plough these furrows back again

* But I have cut off the heads of some myself to try, and could not find that any one would sprout again, though St.-Foin will; perhaps I tried at a wrong season.

to the rows, this will in a manner transplant the upper part of the roots, and bury the grass though it be not dead, by lying open to be dried by the sun. Then harrow the ground to break it more and to level it, and go once over it with a very light roller, to the end that the hay may be raked up the cleaner.

Hence, I suppose, it is that Equivocus pretends to question whether my drill-ploughs will plant the rows of Lucerne any nearer together than thirty inches; but in truth it is as easy to plant them at three inches and a half asunder by a double drill-plough that may be made to plant thirteen rows or more at once; but I think such a distance much to little for any sort of seed, except flax-seed.

I am aware of the common prejudice, which is, that people when they have never seen a plantation of these plants in perfection, are apt to form to themselves the idea of such small ones as they have been used to see; and thence imagine it impossible that this (though a double) number should be sufficient to make a crop. But they might with equal reason imagine the same of apple-trees at a year's growth, which are less than these at the same age, and so plant a thousand trees in the room proper for one. The ancients direct the planting of seventeen cythisus-plants in a perch of ground; and I do not believe that ever those seventeen could yield a crop equal to two hundred twenty-four Lucerne-plants; for as many ounces of hay as each of these yields, so many ton of hay will one crop of an acre produce; thus by weighing the product of one plant (supposing them all equal) the quantity of the crop may be determined, and proved greater than fancy from their number represents.

April 14th, One single unhoed plant of Lucerne had
 thirty-one stalks, which by silver
 money weighed green 25 0

- April 24th, The same dried to hay, weighed . . . 6 6
 14th, The stalks of one single-hoed Lucerne-
 plant green, weighed 56 0
 24th, The same dried 14 6
 14th, Eighteen inches in length of a row,
 being five indifferent plants, weigh-
 ed green, one pound and a half
 avoirdupois.
 24th, Dried to hay it weighed 28 6
 25th, One foot of a hoed row, being one
 hundred and sixty stalks of two
 Lucerne-plants of six or seven
 years old, weighed two pounds,
 green.

But the same dried to the 9th of May weighed

no more than 31 6

Which last is about three tuns to an acre.

This I am certain of, that the least competent number of plants will bring the greatest number of crops; since I see the stalks of a single-hoed plant grow higher in fifteen days, than one amongst near neighbours does in thirty days.

The greatest difference between the culture of this and St.-Foin is, that Lucerne rows should be more grown, before the plants be made single in them by the hand-hoe, lest the fly should destroy some afterwards, and then they might become too thin. For Lucerne is sometimes eaten by the fly, as turnips are, though St.-Foin be never liable to that misfortune, if sown in a proper season. Lucerne must also be more frequently hoed* in some proportion to the more frequent crops it produces.

* The hoe-plough is the instrument to bring it to perfection; but then I doubt it must lie still some years, lest the ploughed earth injure the hay

I shall not go about to compute the difference of expense bestowed in the Roman culture, and in this ; yet it will appear theirs was incomparably more chargeable, and that that excess of charge was occasioned by their error in the theory of husbandry.

They sowed it so thick that the plants must needs be very small, and when ten of them were no bigger than one good single-hoed plant would have been, in the same space of the earth's surface, they could have but a ninth part of the earth's depth, which the one would have had. The defect of depth must be therefore made up in some measure by the extraordinary richness of the surface, upon this account few lands were capable of bearing medica. Their sowing it so late made the first waterings necessary, and the shortness of the roots required the repeated rigations, after the crops were cut ; for Columella saith in Lib. ii. cap. 11. *Cum secueris autem, sæpius eam rigato.* But had it been cultivated by the hoeing method, the tap-roots would have descended as deep as a well, and from the springs below have sent up water to the plants, besides what the hoe would have caused the horizontal roots to receive from dews at the surface above. At how much cheaper rate water is supplied by these means, than by carrying it perhaps a great way, and then sprinkling it by hand

that is made upon it ; (but you may leave every third or fourth interval unhoed for making the hay on, which will yet be more beneficial, if the swarths in mowing should fall thereon. This unhoed interval may be ploughed when there is occasion, and another left in its stead ;) and when it is come to a turf, and the Lucerne wants renewing, the four-coultered plough is the only instrument that can prepare the turf to be killed, and cure the Lucerne ; which plough must be used in the following manner ; Turn its furrows towards one row, and from the next ; that is, plough round one row, and that will finish two intervals, and so on ; and the next ploughing must be towards those rows, from whence they were turned the first time : take care the first furrows do not lie long enough on the rows to kill the plants, which will be much longer in winter than in summer.

over the beds, which were made ten feet wide between path and path for that purpose, let any one judge. As also what a laborious task it was to pick out the grass with fingers from amongst it, in the hard dry ground in the summer, after mowing the crop, as Columella directs in his forementioned chapter, which the horse-hoe would have done with ease at a twentieth part of that expense. However, since they saw the medica was as impatient of grass as the vineyards were, it is a wonder they did not give it the same culture with the bidens, which would have been much better and cheaper, than to cleanse the medica with fingers. Indeed, fingers were made before the bidens; but surely the effect of its use in raising juices to the vine had inspired the Romans with more judicious speculations, than to give that for a reason why they hoed the medica with their fingers, rather than with the bidens.

Oh! but this was made with iron, and medica had in those times an antipathy to iron; and after it was sown the place must not be touched by that metal; therefore the seed must not be covered with a plough, nor with iron harrows. But if they had made trials enough, to know that half an inch was the proper depth to cover this seed at, these virtuosi would have been convinced, that it had no less antipathy to these instruments, of what matter soever they were made, if they buried it five or six inches deep, which the plough must do, and the weight of iron harrows in such fine ground, not much less. Had the plough been all of wood, the furrow would have lain never the lighter upon the seed; and if the wooden harrows had been loaded with a weight capable of pressing it down as deep, it would have been no more able to rise, than if it had been buried with iron harrows. This Columella seems to be sensible of when he says, *Rastellis Ligneis*, viz., that it was not sufficient for them to be made of wood, unless they were diminutive, for then they were light ones. It is probable the plough suffered none to come up, and the

heavy harrows very few, though perhaps plants enough, had they calculated what number were sufficient; but, unless the ground were cultivated with them at first, it seems they had not patience to wait till the plants grew large enough to fill it with a bare competent number; and thought it not worth while to weed and water what they fancied to be an insufficient number. It was expected that the thickness of the plants should help to kill the grass; yet upon due observation it was found that, when their excessive numbers have brought a famine amongst them, they are forced to pray upon one another; and though the stronger survive, yet even those are so weakened by hunger that they become the less able to contend with grass whose good fortune it was that superstition would not permit the Romans to interpose, by attacking it with iron weapons.

I hope these hints may be improved for the abolition of old errors, and for the discovery of new truths; to the end that Lucerne may be planted in a more reasonable method than has been commonly practised: and when the theory is true, it is impossible the practice should be false, if rightly applied; but if it fail of success, the event will be a proof either of a misapplication, or that the theory is false.

Lucerne should be ordered for hay in the same manner as is directed for St.-Foin in the foregoing Chapter: but it must be observed, that Lucerne is more worsted by being suffered to survive its virginity before cutting; and therefore the richest and most nourishing hay is cut whilst the stalks are single, without any collateral branches shooting out of them; and when they are so, neither blossoms nor even their buds appear. But of that sown in the old fashion, the last crops for want of a new supply of nourishment grow so slowly, that, ere it is high enough to be cut, the blossoms are blown out, and the stalks, though very small, are become

woody, hard, and dry, and make the hay nothing near so nourishing as that of the first crops.

But in that which is hoed, the last crops will, by virtue of the greater quantity of nourishment it receives, grow faster, and be of a height fit to cut before blossoming, and thence being as young and vigorous, make as good hay as the first crops; so that hoeing does not only procure more and larger crops, but also better hay.

This is most certain, that unless we can keep our Lucerne pretty clean from natural grass, we cannot expect it to succeed let the soil be ever so proper.

I have not one field that is either warm enough or rich enough for me to expect success in planting Lucerne on it.

The following Five Chapters have been formerly published as a Specimen.

CHAPTER XVI.

OF CHANGE OF SPECIES.

- I. That plants of the most different nature feed on the same sort of food.
- II. That there is no plant but what must rob any other plant within its reach.
- III. That a soil which is proper to one sort of vegetable, once, is, in respect of the sort of food it gives, proper to it always.

If any one of these Three Propositions be true, as I hope to prove all of them are, then it will follow, that there is no need to change the species of vegetables from one year to another, in respect to the different food the same soil is, though falsely, supposed to yield*.

The common opinion is contrary to all these (as it must be, if contrary to any one of them); and since an error in this fundamental principle of vegetation is of very ill consequence; and since Dr. Woodward, who has been serviceable in other respects † to this art, has unhappily fallen in with the vulgar in this point, his arguments for this error require to be answered in the first place.

The Doctor says ‡, “It is not impossible to imagine how
“ one uniform, homogeneous matter having its principles, or
“ original parts, all of the same substance, constitution, mag-

* For if all plants rob one another, it must be because they all feed on the same sort of food; and admitting they do, there can be no necessity of changing the species of them from one soil to another; but the same quantity of the same food, with the same heat and moisture which maintains any species one year, must do it any other year.

† By proving in his Experiments, that earth is the *pabulum* of plants.

‡ In Philos. Trans. N. 253.

“ nitude, figure, and gravity, should ever constitute bodies
 “ so egregiously unlike, in all those respects, as vegetables
 “ of different kinds are ; nay, even as the different parts of
 “ the same vegetable.

“ That there should be that vast difference in them, in
 “ their several constitutions, makes, properties, and effects,
 “ and yet all arise from the very same sort of matter, would
 “ be very strange.”

Answer. It is very probable, that the terrestrial particles which constitute vegetables, though inconceivably minute, may be of great variety of figure and other differences, else they could not be capable of the several ferments, &c., they must undergo in the vessels of plants. Their smallness can be no objection to their variety, since even the particles of light are of various kinds.

But as the Doctor asserts, “ that each part of the same
 “ vegetable requires a peculiar specific matter for its forma-
 “ tion and nourishment ; and that there are very many and
 “ different ingredients go to the composition of the same
 “ individual plants,”—

From hence must be inferred, that the same plant takes in very many and different ingredients (and it is proved, that no plant refuses any ingredient that is capable of entering its roots*.) Though the terrestrial particles which nourish vegetables be not perfectly homogeneous, yet most of the various tastes and flavours of plants are made in and by the vessels†.

* Dr. Grew, in his anatomy of plants by microscopical inspection, found, that the outer superficies of roots was of a spongy substance ; and it is well known that no such body can refuse to imbibe whatever liquor comes in contact with it, but will by its springy porosity absorb any sort of moisture.

† We are convinced that it is the vessels of plants that make the different flavours ; because there is none of these flavours in the earth of which they are made, until that has entered and been altered by the vegetable vessels.

Dr. Woodward says, “ that water will pass pores and interstices, that neither air, nor any other fluid will ; this enables it to enter the finest tubes and vessels of plants, and to introduce the terrestrial matter, conveying it to all parts of them ; whilst each, by means of organs it is endowed with for the purpose, intercepts and assumes into itself such particles as are suitable to its own nature*, letting the rest pass on through the common ducts.”

Here, then, he says plainly, that each plant receives the terrestrial matter in gross, both suitable and unsuitable to its nature, retains the suitable particles for its augment, and the unsuitable lets pass through it. And in another place, he says, they are exhaled into the atmosphere.

And this will appear to be the true case of plants ; and directly contradicts what he advances, in saying, “ that each sort of grain takes forth that peculiar matter that is proper for its own nourishment. First, the wheat draws

* If the Doctor's plants were so nice in leaving vegetable matter behind, quiet and undisturbed, it is a wonder they would take up the mineral matter, as he says they did that killed themselves with nitre.

These plants might with much less difficulty have distinguished the mineral matter from the vegetable matter, than they could distinguish the different particles of vegetable matter from one another, and must have been very unwise to choose out the nitre (their poison) from the water and earth, and to leave the vegetable particles behind ; none of which could be so improper to them as the nitre.

It may, perhaps, be objected, that such like pernicious matter kills a plant by only destroying its roots, and by closing the pores, which prevents the nourishment from entering to maintain its life ; and that such matter doth not itself enter to act as poison upon the sap, or upon the vessels of the body, or leaves : but it plainly appears that it doth enter, and act as poison ; for when some of the roots of a mint, growing in water, are put into salt water, it kills the whole plant, although the rest of the roots remaining in the fresh water were sufficient to maintain it, if the other roots had been cut off at the time they were removed into the salt water ; and also all the leaves, when dead, will be full of salt.

Or if the juice of wild garlic-seed be made use of instead of the salt water, it will have the same effect ; and every one of the mint leaves will have a strong taste of garlic in it.

“ off those particles that suit the body of that plant, the rest
 “ lying all quiet and undisturbed the while. And when the
 “ earth has yielded up all of them, those that are proper for
 “ barley, a different grain, remain still behind, till the suc-
 “ cessive crops of that corn fetch them forth too ; and so the
 “ oats and peas in their turn, till, in fine, all is carried off.”

In the former paragraph he says, each plant lets pass through it the rest of the particles that are not suitable to its own nature. In the latter paragraph he says, that each leaves the unsuitable all behind for another sort ; and so on. Both cannot be true.

If the latter were true, change of sorts would be as necessary as it is commonly thought. But if the former be true, as I hope to prove it is, then there can be no use of changing of sorts in respect of different nourishment.

Query, Whether Equivocus's allowing, that the same nourishment is common to all plants, and proper to none ; and yet affirming the necessity of changing the species of plants on account of the quality of the nourishment, doth not in effect grant the premises, and deny the conclusion ?

If in this series of crops each sort was so just as to take only such particles as are peculiarly proper to it, letting all the rest alone to the other sorts to which they belonged, as the Doctor imagines, then it would be equal to them all, which of the sorts were sown first or last : but let the wheat be sown after the barley, peas, and oats, instead of being sown before them, and then it would evidently appear by that starved crop of wheat, either that some, or all of those other grains, had violated this natural probity, or else that nature has given to vegetables no such law of *meum* and *tuum**.

* A charlock could not rob a turnip and starve it more than several turnips can do, unless the charlock did take from it the same particles

If these things were as the Doctor affirms, why do farmers lose a year's rent, and be at the charge of fallowing and manuring their land, after so few crops, since there are many more sorts of grain as different from these and one another, as those are which they usually sow?

They still find that the first crops are best, and the longer they continue sowing, the worse the last crops will prove, be they of never so different a species; unless the land were not in so good tilth for the first crop as for the subsequent, or unless the last sown be of a more robust species.

This matter might be easily cleared, could we perfectly know the nature of those supposed unsuitable* particles; but, in truth, there is no more to be known of such of them, than that they are carried away by the atmosphere to a distance, according to the velocity of the air, perhaps several miles off, at least never likely to return to the spot of ground from whence the plants have raised them.

But suppose these cast-off particles, were, when taken in, unfit for the nourishment of any manner of vegetables: then

which would nourish a turnip; and unless the charlock did devour a greater quantity of that nourishment than several turnips could take.

Flax, oats, and poppy, could not burn or waste the soil, and make it less able to produce succeeding crops of different species, unless they did exhaust the same particles which would have nourished plants of different species; for, let the quantity of particles these burners take be never so great, the following crops would not miss them, or suffer any damage by the want or loss of them, were they not the same particles which would have nourished those crops if the burners had left them behind, quiet and undisturbed. Neither could weeds be of any prejudice to corn, if they did draw off those particles only that suit the bodies of weeds, the rest lying all quiet and undisturbed the while. But constant experience shows, that all sorts of weeds, more or less, diminish the crop of corn.

* But we must not conclude that these particles, which pass through a plant (being a vastly greater quantity than those that abide in it for its augment) are all unsuitable, because no one of them happens to hit upon a fit *nidus*: for since the life of animals depends upon that of plants, it is not unreasonable to imagine that nature may have provided a considerable overplus for maintaining the life of individual plants, when she has provided such an innumerable overplus for continuing every species of animals.

the Doctor must fancy the wheat to be of a very scrupulous conscience, to feed on these particles, which were neither fit for its own nourishment, nor of any other plant, and at the same time to forbear to take the food of barley, peas, and oats, letting that *lie still and undisturbed the while*, as he says it does, though he gives no manner of reason for it.

It is needless to bring stronger arguments than the Doctor's experiments afford, against his own vulgar opinion, of plants distinguishing the particular sort of terrestrial matter that he says is proper to each sort of vegetable, in these words, viz., "Each sort takes forth that peculiar matter that " is proper for its own nourishment, the *rest lying all quiet* " *and undisturbed the while.*"

He says, that great part of the terrestrial matter, mixed with the water, passes up into the plant along with it, which it could not do if only the peculiar matter proper to each plant did pass up into it; and after he has shown how apt the vegetable matter is to attend water in all its motions, and to follow it into each of its recesses, being by no filtrations or percolations wholly separable from it, it is strange he should think that each plant leaves the greatest part of it behind, separated from the water which the plant imbibes.

There are, doubtless, more than a million of sorts of plants, all of which would have taken up the water, and had each as much right to its share, or proper matter in it, as the Doctor's plants had; and then there would be but a very small (or a millionth) part of it proper to each of his plants, and these, leaving all the rest behind, both of the water wherewith the glasses at first were filled when the plants were put into them, and also of all the additional water daily supplied into them afterwards: I say, so much more terrestrial matter brought into these glasses, in proportion to the added water, and so very small a part as could be proper to each of his plants being carried off; there must have remained in these

glasses a much greater quantity of terrestrial matter at the end of the experiment, than remained in the glasses *F* or *G*, which had no plants in them, nor any water added to or diminished from them, but quite the contrary appeared. “ And the water in the glasses *F* and *G* at the end of the “ experiment, exhibited a larger quantity of terrestrial matter than any of those that had plants in them did. The “ sediment at the bottom of the glasses was greater, and the “ *nubeculæ* diffused through the body of the water thicker.” Had the *cataputia* insumed with the two thousand five hundred and one grains of water, no more than its proper share of the vegetable matter, it could not have attained thence an increase of three grains and a quarter, nor even the thousandth part of one grain. But he found “ This terrestrial “ matter, contained in all water, to be of two kinds: the “ one properly a vegetable matter, but consisting of very “ different particles, some of which are proper for the nourishment of some kinds of plants, others for different sorts, “ &c.”

This, indeed, would have been a most wonderful discovery, and might have given us a great light, if he had told us in what language and character these proper differences were stamped or written upon the vegetable particles; which particles themselves, he says, were scarce visible. Certainly it must be a great art (much beyond that of Doctor Wallis) to decipher the language of plants from invisible characters.

Doctor Woodward seems to have had as good eyes and as strong an imagination as the old woman who saw the needle upon the barn but could not see the barn.

I will by no means call in question the veracity of so learned and good a man, and therefore am willing to believe he made this extraordinary observation in his sleep.

I am reproached by Equivocus for insulting the ashes of this gentleman, but in truth he was living when I wrote this

Chapter ; I am sure I believed so : and I hope what I have written can no way reflect upon the Doctor's memory, but as he was a man, and liable to be deceived by too great a zeal for a favourite hypothesis, which sometimes makes one imagine one sees a thing that has no real existence. This observation of the Doctor's, as he expresses it, seeming to have been made by inspection upon a glass of water with earth in it, for the discovery of all the different sorts of particles in that earth ; if I had contradicted the result of his observation concerning the "vegetable matter, consisting of very different " particles, some of which (the Doctor says) are proper for " the nourishment of some kinds of plants, others for different sorts, &c.;" as to the fact related from a clear ocular inspection, it might have reflected more on the Doctor's ingenuity, than to impute it, as I have, to the effect of mere imagination, seduced by a zeal for his hypothesis.

However, at the worst, I presume the refuting and exposing an error so injurious to mankind, may atone for an expression or two in my arguments thereupon, which are not injurious to the probity or veracity of him who advanced that error, but that are rather an excuse for his mistake ; and if Equivocus speaks true, when he saith that Columella's first Essay was written to ridicule an error of his contemporaries, why should not an error so fundamental as this be ridiculed now, since its being shown to be ridiculous is an argument that weighs more with many husbandmen, than demonstration ? And I think that no argument consistent with truth, should be omitted, which can any way conduce to the establishing a principle that is essential towards treating of agriculture as a science.

But that this dream may deceive none, except such as are very fond of old errors, there is an *experimentum crucis* which may enovince them, viz., at the proper season, tap a birch-tree in the body or boughs, and you may have thence a large

quantity of clear liquor, very little altered from water, and you may see that every other species of plants that will grow in water, will receive this, live, and grow in it, as well as in common water. You may make a like experiment by tapping other trees, or by water distilled from vegetables, and you will find no species of plants into which this water will not enter, and pass through it, and nourish it too, unless it be such a species as requires more heat than water admits; or unless the peculiar vessels of that it has first passed through have so altered the vegetable particles contained in that water, as that it acts as poison upon some other particular species.

The Doctor concludes, “ That water is only the agent
“ that conveys the vegetable matter to the bodies of plants,
“ that introduces and distributes it to their several parts for
“ their nourishment. That matter is sluggish and inactive,
“ and would lie eternally confined to its beds of earth, with-
“ out ever advancing up into plants, did not water, or some
“ like instrument, fetch it forth, and carry it unto them.”

That water is very capable of the office of a carrier to plants, I think the Doctor has made most evident; but as to the office of such an agent as his hypothesis bestows upon it, it seems impossible to be executed by water. For it cannot be imagined that water, being itself but mere homogenous matter, void of all degrees of life, should distinguish each particle of vegetable matter, proper and peculiar to every different species of plants, which are innumerable; and when it is to act for the wheat, to find out all the particles proper to that sort of grain, to rouse only those particular sluggards from their beds of earth, letting all the rest lie quiet and undisturbed the while. This agent frees the wheat particles from their confinement, and conveys, introduces, and distributes them, and only them, into the several parts of the wheat.

Certainly no mortal, except Doctor Woodward, can pretend to distinguish the particles of vegetable matter by any characters, hieroglyphics, or other manner whatever, so as to determine to what species, or class of plants, they are severally proper and peculiar; neither is it probable, that any botanist is acquainted with half the distinct species of vegetables. Yet all the vegetable particles, and all the species of vegetables, must be perfectly and distinctly known by water, before it be capable of performing such a nice task of an agent; else, when wheat, barley, and oats, are all growing together, in the same foot of ground, with their roots so entangled together, that no man can possibly distinguish the one from the other, by viewing the roots how should this insensible agent be punctual in delivering to each its own proper particles? For, though the agent had most exactly executed a commission of disturbing the inactivity of these three sorts of particles only; yet, when it had fetched them forth, if it should err in the delivery of them, and carry the wheat-particles to the barley, and those of barley to the oats, it would be a mistake of worse consequence, according to the Doctor's opinion, than that of the London undertaker's, who being to inter an old man in Northumberland, and a young lady in Cornwall, carried the man to Cornwall, and the lady to Northumberland. Her mother, for mitigation of grief, would not be satisfied without a last sight of her daughter's corpse; but, when the coffin was opened, the error was discovered by the indubitable criterion of an old shrivelled face, with a huge grey beard. It is no real injury to a person deceased, if the place of his burial be mistaken; but if water should mistake thus in the taking up, carrying, and delivery of vegetable particles, all plants would be (upon the Doctor's hypothesis) starved or poisoned, and animals could not long survive all plants. But since all the different species of plants do continue to live, their life proves, that the vegetable par-

ticles of earth are not proper, but common to them all for their nourishment, if these particles are taken up, carried, and introduced into the vegetable vessels by water; which is capable of distinguishing neither different vegetable particles, nor different vegetables.

Since it is unreasonable to believe, that water can have such extraordinary skill in botany, or in micrography, as to be qualified for a sufficient agent in such an abstruse matter, I conceive water to be only an instrument or vehicle, which takes up indifferently any particles it meets with (and is able to carry) and advances them (or the pabulum they yield) up into the first plant whose roots it comes in contact with; and that every plant it meets with, does accept thereof, without distinguishing any different sorts or properties in them, until they be so far introduced and advanced up into the vegetable vessels, that it would be in vain to distinguish them; for whether the terrestrial matter plants imbibe with the water will kill or nourish them, appears by its effects; but which cannot be foreknown or prevented without the help of faculties, which plants are not endowed with.

Mr. Bradley seems to have carried this error further than any author ever did before; but he supports it by affirmations only, or by such arguments (I cannot say reasons, for no reason can be against any truth) as go near to confute the very opinion he pretends to advance by them.

He ascribes to vegetables the sense of taste, by which, he thinks, they take such nourishment as is most agreeable to their respective natures, refusing the rest; and will rather starve than eat what is disagreeable to their palate.

In the Preface to his Vol. I. page 10, of his Husbandry and Gardening, he says, "They feed as differently as horses do from dogs, or dogs from fish."

But what does he mean by this instance, Vol. I. p. 39, viz., "That thyme, and other aromatics, being planted near an

“apricot-tree, would destroy that tree, helps to confirm, that every plant does not draw exactly the same share of nourishment?”

I believe there is no need for him to give more instances to disprove his assertion than this one. His conclusion, taken by itself, is so far right, viz., “That if the nourishment the earth afforded to the thyme and apricot-tree had been divided into two shares, both could not have had them.”

But this his instance proves, that those aromatics robbed the apricot-tree of so much of its share as to starve it; and that they, though of so very different a nature, did draw from the earth the same nourishment which the apricot-tree should have taken for its support, had not the aromatics been too hard for it, in drawing it off for their own maintenance.

Unless he believes that all the juices of the aromatics were as poison to the apricot; and that, according to my experiment of the mints *G.* and *H H.*, some of their roots might discharge some kind of moisture in dry weather, given them by others, that had it for their use; and that the apricot-roots mingling with them, might imbibe enough of that liquor, altered sufficiently by their vessels, to poison and kill the tree.

Some of the Anticircularians (but Mr. Bradley was not one) may believe, that the chyle is altered and made into sap in the roots; but the experiment of my mint (*G*) will show that no such alteration is made in the roots.

But then, where was the tree’s distinguishing palate? Why did it not refuse this juice, which was so disagreeable as to kill it? And as to his notion of vegetables having palates, let us see how it agrees with what he affirms:

“That it is the vessels of plants that make, by their filtrations, percolations, &c., all the different tastes and flavours of the matter, which is the aliment of plants; and that before it be by them so filtered, &c., it is only a fund of

“ insipid substance, capable of being altered by such vessels,
“ into any form, colour, or flavour.”

And Vol. I. p. 38 : “The different strainers, or vessels of the several plants, growing upon that spot of earth, thus impregnated with salts, alter those salts or juices, according to the several figures or dimensions of their strainers ; so that one plant varies, in taste and smell, from others, though all draw their nourishment from the same stock lodged in the earth.” See Mr. Bradley’s *Palates of Plants*, and the insipid substance he allots them to distinguish the taste of, how they agree.

They must, it seems, within their own bodies, give the flavour to this insipid substance, before their palates can be of any use ; and even then, it is impossible to be of any use, but in the manner of the dog returning to his vomit.

They would have as much occasion for the sense of smelling, as of taste ; but after all, of what use could either of the two be to plants, without local motion of their roots, which they are so destitute of, that no mouth of a root can ever remove itself from the very point where it was first formed ; because a root has all its longitudinal increase at the very end : for should the spaces betwixt the branchings increase in length, those branches would be broken off and left behind, or else drawn out of their cavities, which must destroy the plant. All the branches, except the foremost, would be found with their extremities pointing towards the stem ; the contrary of which posture they are seen to have : and if they moved backwards, that would have much the same effect on all the collateral branchings to destroy them. Smell and taste then could be of no manner of use to vegetables, if they had them ; they would have no remedy or possibility to mend themselves from the same mouths, removing to search out other food, in case they had power to dislike or refuse what was offered them.

Therefore, the crude earth being their food, simple and free from any alterations by vessels remaining insipid, cannot give, neither can plants receive, require, or make use of any variety from it, as animals do from their diet. It would be lost upon them, and nature would have acted in vain, to give smell and taste to vegetables, and nothing but insipid earth for an object of them; or to give them a charming variety of relish and savour in their food, without giving them senses necessary to perceive or enjoy them; which would be like light and colours to the blind, sound and music to the deaf; or like giving eyes and ears to animals, without light or sound to affect them.

The mouth of plants, situate in the convex superficies of roots, are analogous to the lacteals, or mouths, in the concave superficies of the intestines of animals.

These spongy superficies of animal guts, and vegetable roots, have no more taste or power of refusing whatever comes in contact with them, the one than the other.

The free open air would be equally injurious to both: and if exposed to it, it would dry and close up the fine orifices in guts and roots; therefore nature has guarded both from it.

Nature has also provided for the preservation of both vegetables and animals (I do not say equally) in respect of their food), which might poison them, or might not be fit to nourish them.

The security of plants (the best that can be) is their food itself, earth; which having been altered by no vessels, is always safe and nourishing to them: for a plant is never known to be poisoned by its own natural soil, nor starved, if it were enough of it with the requisite quantities of heat and moisture.

Roots being therefore the guts of plants, have no need to be guarded by senses; and all the parts and passages, which serve to distinguish and prepare the food of animals, before

it reach the guts, are omitted in plants, and not at all necessary to them.

But as the food of most animals is earth, very variously changed and modified by vegetable or animal vessels, or by both, and some of it is made wholesome, some poisonous ; so that if this doubtful food should be committed to the intestines, without examination, as the pure unaltered earth is to roots, there would, in all probability, be very few animals living in the world, except there be any that feed on earth at first hand only, as plants do.

Therefore, lest this food, so much more refined than that of plants, should, by that very means, become a fatal curse, instead of a blessing to animals, nature has endowed them with smell and taste, as sentinels, without whose scrutiny these various uncertain ingredients are not admitted to come where they can enter the lacteals, and to distinguish, at a sufficient distance, what is wholesome and friendly, from what is hurtful ; for when it is once passed out of the stomach into the guts, it is too late to have benefit from emetics ; its venom must then be imbibed by the lacteal mouths, and mix with the blood, as that must mix with the sap, which comes in contact with the lacteals in the superficies of roots, nature having left this unguarded.

The nutriment, or chyle, that a root takes in, must mix with the sap in the leaves, unless some of it happens to pass out at other roots in the manner described in my note upon Circulation.

Yet, plants seem to be better secured by the salubrity and simplicity of their food, than animals are by their senses. To compensate that inequality of danger, animals have pleasure from their senses, except some miserable animals (and such there are) that have more pain than pleasure from them. But, I suppose, more animals than plants are poisoned ; and that a poisonous animal is less fatal to a plant, than a poisonous

plant is to an animal. An instance of this—I have been told, by very credible persons, that a man walking in a garden, gathered a sprig of sage, and eat it, which soon brought upon him the symptoms of poison and death. They dug up the root of sage, and found a toad under it.

Some of the effluvia or excrementitious juices of this loathsome animal had passed the vessels of that wholesome plant, without any apparent injury to it, though all its strainers were not able to correct the venom.

Here I remark that the mint (*E*) suffered more pestiferous effects from the garlic, of its own genus, than the sage did from the toad, though of a different genus.

It killed the man, but was not strong enough to kill the sage. This shows that plants have not occasion of palates, as animals have.

I say no more of Mr. Bradley's vegetable palates; I proceed to some other arguments against the necessity of changing sorts of vegetables, on account of their taking different nourishment.

It being sufficiently proved, that every sort of vegetable, growing in the same soil, takes, and is nourished by the same sort of food, it follows from hence, that the beneficial change of sorts of seeds or plants, we see in the common husbandry, is not from the quality of the sorts of food, but from other causes; such as,

- I. Quantity of the food.
- II. Constitution of the plants.
- III. Quantity of the tillage.

In Dr. Woodward's case upon this hypothesis, the three proportions of seeds, viz., barley, oats, and peas, may be sown all together in the same acre of ground, the same year, and make three as good crops as if sown singly in three successive years, and his two crops of wheat in one year likewise. But every farmer can tell that these three proportions of seed

would not yield half the crop together, as one would do single ; and would scarce produce more than to show what grains were sown, and which of the sorts were the strongest, and the most able robber.

Though this failure would, in truth, be from no other cause than want of the sufficient quantity of food, which those three crops required ; yet, perhaps, the doctor might think that all three crops might succeed together very well, taking each its proper nourishment, were it not for want of room, air, and sun.

I have been credibly informed, that on one perch of ground there has grown a bushel of corn, which is twenty quarters to an acre. Mr. Houghton relates twenty-six, and even thirty quarters of wheat on one acre. There has certainly grown twelve quarters of barley to an acre, throughout a whole field ; therefore, unless a crop exceed the least of these, or, indeed, the greatest of them (if the relation be true) a crop cannot fail for want of room ; for one acre (be it of what nature it will, as to the soil of it) must have as much room for a crop to grow on, as any other acre.

Then there was room for all Dr. Woodward's three crops together, to produce as much as three common crops do. Yet all these together will scarce yield one quarter of corn, though there is room at least for twelve.

The same air and sun that had room to do their office to Mr. Houghton's acre, why should they not have room to do the same to Dr. Woodward's acre, when the three crops growing on it at once, though pretty good ones, might require less room than Mr. Houghton's crop did ?

I perceive that those authors, who explain vegetation, by saying the earth imbibes certain qualities from the air, and by specific qualities, and the like, do also lay a great stress upon the perpendicular growth of vegetables ; seeming to fancy there is little else necessary to a good crop, but room.

Mr. Bradley, in his arguments concerning the value of a hill, does implicitly say as much.

But if they would but consider the diameters of the stems, with the measure of the surface of an acre, they would be convinced, that many, even of Mr. Houghton's crops, might stand in a perpendicular posture upon an acre, and room be left.

One true cause of a crop's failing, is want of a quantity of food to maintain the quantity of vegetables which the food should nourish.

When the quantity of food which is sufficient for another species (that requires less), but not for that which last grew, to grow again the next year, then that other is beneficial to be planted after it.

The second true cause is from the constitution of plants; some require more food than others, and some are of a stronger make, and better able to penetrate the earth, and forage for themselves.

Therefore oats may succeed a crop of wheat on strong land, with once ploughing, when barley will not; because barley is not so well able to penetrate as oats, or beans, or peas are.

So a pear-tree may succeed a plum-tree, when another plum-tree cannot; because a pear is a much stronger tree, and grows to a much greater bulk, so inclined to be a giant, that it is hard to make it a dwarf; and will penetrate and force its way through the untilled earth, where the other cannot, being of a weaker and less robust constitution, not so well able to shift for itself.

The pear could penetrate pores that the other could not. Mr. Evelyn says, in his *Discourse of Forest-Trees*, "that a pear will strike root through the roughest and "most impenetrable rocks and cliffs of stone itself." He says likewise, in his *Pomona*, "that pears will thrive

“ where neither apple or other fruit could, in appearance, be expected.”

I can scarce think that a large plant takes in larger particles than a small one for its nourishment; if it did, I cannot believe, that the thyme could have starved the apricot-tree; it must have left the larger particles of food for that tree, which probably would have sufficed to keep it alive; I rather think, that great and small plants are sustained by the same minute particles; for as the fine particles of oats will nourish an ox, so they will nourish a tomtit, or a mite.

Some plants are of a hotter constitution, and have a quicker digestion, like cormorants or pigeons, devouring more greedily, and a greater quantity of food than those of a colder temperature, of equal bulk, whose sap having a more languid motion, in proportion to the less degree of heat in it, sends off fewer recrements, and therefore a less supply of food is required in their room. This may make some difference in the one succeeding the other; because the hot-constitutioned leaves not enough for its own species to succeed again, but leaves enough for a species of a colder constitution to succeed it.

But the third and chief cause of the benefit of changing sorts, is quantity of tillage, in proportion to which the food will be produced.

The true cause why wheat is not (especially on any strong soil) to be sown immediately after wheat, is, that the first wheat standing almost a year on the ground, by which it must grow harder, and wheat seed-time being soon after harvest, in England, there is not space of time to till the land so much as a second crop of wheat requires.

Though sometimes, in poorer land that is lighter, wheat has succeeded wheat with tolerable success, when I have seen, on very rich strong land, the first crop lost by being

much too big, and one following it immediately, quite lost by the poorness of it, and not worth cutting.

This was enough to satisfy, that the tillage, which was so much easier performed in less time, sufficed for the light land, but not for the strong; and if the strong land could have been brought into as good tilth as the light (like as in the new husbandry it may), it would have produced a much better second crop than the light land did.

From all that has been said, these may be laid down as maxims, viz., that the same quantity of tillage will produce the same quantity of food in the same land; and that the same quantity of food will maintain the same quantity of vegetables.

Add *cæteris paribus*; for when the land has been more exhausted, more tillage (or dung) or rest will be required to produce the same quantity of food, than when the land hath been less exhausted. By tillage is here meant, not only the number of ploughings, but the degree of division or pulverisation of the soil; or if perchance the soil is extraordinarily much exhausted by many crops without proper tillage between them, the greater degree of pulverisation, by ploughing or dung (which is only a succedaneum of tillage), and also a longer time of exposure may be necessary to counterpoise that extraordinary exhaustion.

It is seen, that the same sort of weeds which once come naturally in a soil, if suffered to grow, will always prosper in proportion to the tillage and manure bestowed upon it, without any change. (And so are all manner of plants that have been yet tried by the new husbandry, seen to do.)

A vineyard, if not tilled, will soon decay, even in rich ground, as may be seen by those in France, lying intermingled as our lands do in common fields. Those lands of vines, which by reason of some law-suit depending about the property of them, or otherwise, lie a year or two untilled,

produce no grapes, send out no shoots hardly; the leaves look yellow, and seem dead, in comparison of those on each side of them, which, being tilled, are full of fruit, send out a hundred times more wood, and their leaves are large and flourishing; and continue the same annually for ages, if the plough or hoe do not neglect them.

No change of sorts is needful in them, if the same annual quantity of tillage (which appears to provide the same annual quantity of food) be continued to the vines.

But what in the vineyards proves this thesis most fully, is, that where they constantly till the low vines with the plough, which is almost the same with the hoe-plough, the stems are planted about four feet asunder, chequer-wise; so that they plough them four ways. When any of these plants happen to die, new ones are immediately planted in their room, and exactly in the points or angles where the others have rotted; else, if planted out of those angles, they would stand in the way of the plough. These young vines, I say, so planted in the very graves, as it were, of their predecessors, grow, thrive, and prosper well, the soil being thus constantly tilled; and if a plum-tree, or any other plant had such tillage, it might as well succeed one of its own species, as those vines do.

It is observed, that white-thorns will not prosper, set in the gaps of a white-thorn hedge; but I have seen the banks of such gaps dug, and thrown down one summer, and made up again, and white-thorns there replanted the following winter, with good success.

But note, that the annual ploughing the vines is more beneficial than the one summer tillage of the banks, the vines having it repeated to them yearly.

I have, by experience and observation, found it to be a rule, that long, tap-rooted plants, as clover and St.-Foin, will not succeed immediately after those of their own or any

other species of long tap-roots, so well as after horizontal-rooted plants; but, on the contrary, horizontal will succeed those tap-roots as well or better than they will succeed horizontal.

I confess, this observation did, for a great while, cheat me into the common belief, that different species of plants feed on different food; till I was delivered from that error, by taking notice, that those tap-roots would thrive exceedingly well after turnips, which have also pretty long tap-roots, though turnips never thrive well immediately after clover or St.-Foin; I found the true cause of this exception to that rule, to be chiefly the different tillage*.

But when clover hath been fed by cattle, and the ground being good and well tilled, turnips may thrive immediately after clover; therefore this is an exception to the general rule.

Land must be well tilled for turnips, which also are commonly hoed; they stand scarce ever above three quarters of a year, and are then fed on the ground, and then the succeeding crop of corn has, by that means, the benefit of twice as much tillage from the hoe as otherwise would be given to it; and the broad clover or St.-Foin, sown with the corn (if the corn be not so big as to kill it), will enjoy, in its turn, a proportion of the extraordinary tillage, and of the dung of cattle, which feed the turnips, and thrive accordingly; but broad clover and St.-Foin, being perennial plants, stand on the ground so long, that it lies several years untilled; so that turnips sown immediately after these, do fail, for want of their due tillage, for which there is not sufficient time, by ploughing often enough, because, by the common ploughs, it requires two or three years to make it fine enough for tur-

* Very mellow, rich land is so full of vegetable food, that it is an exception to most rules; and therefore I speak not of that.

nips, or for a repetition of clover or St.-Foin, in strong or swerdy land.

Another reason why any crop succeeds well after turnips (and besides their being spent on the ground where they grow), is their cold constitution, by which they are maintained with less food than another plant of the same bulk.

The parenchyma, or fleshy part of a turnip, consisting of a watery substance, which cools the vessels, whereby the sap's motion is very slow, in proportion to the very low degree of heat it has, and sends off its recrements in the same proportion likewise; and therefore requires the less of the terrene nourishment to supply those recrements.

A turnip, it is like, has larger chyle-vessels in proportion to its sap-vessels, than many other sorts of plants have; and the greatest part of this chyle being water, it may well be supposed colder than sap.

This is seen when a bushel of turnips, mixed with a quantity of wheaten flour, is made into bread, and well baked; this bushel of turnips gives but few ounces increase in weight, more than the same quantity of wheaten flour made into bread, and baked without any turnips. This shows there is in a turnip very little earth (which is the most permanent substance of a plant), the oven discharges, in vapour, near all but the largest vessels; its earthy substance being so small, is a proof it is maintained by a small quantity of earth; and upon that account, also of less damage to the next crop than another plant would be, which required more of the solid nourishment to constitute its firmer body, as a charlock does; for when a charlock comes up, contiguous to, and, at the same time with, a turnip, it does so rob the turnip, that it attains not to be of the weight of five ounces; when a single turnip, having no more scope of ground, and, in all respects (but the vicinity of the charlock) equal, weighs five pounds, yet that charlock does not weigh one pound.

And where three turnips coming up, and growing thus contiguous, will weigh four pounds, a charlock joined with two or three turnips, all together will be less than one pound, upon no less space of ground.

This observation cannot be made except where turnips are drilled in rows; and there it is easy to demonstrate, that a charlock, during the time of its short life, draws much more earth than a turnip of equal bulk, from an equal quantity of ground*.

The true cause why clover and St.-Foin do not succeed so well after their own respective species, or that of each other, as corn, &c. can, is, that they take great part of their nourishment from below the plough's reach, so as that under-earth cannot be tilled deep enough, but the upper part may be tilled deep enough for the horizontal roots of corn, &c., towards which the rotting of the clover and St.-Foin roots, when cut off by the plough, do not a little contribute. And there is doubt but that, if the under-earth could be as well tilled for the tap-roots, as the upper-earth is for the horizontal, the tap-roots would succeed one another as well as the horizontal would succeed them, or those of their own species, or, as the tap-roots do the horizontal.

That the rotting of vegetable roots in the ground doth ferment therein, and improve it for horizontal-rooted plants, I am convinced by an accident, viz., my man had ploughed off

* It is certain that turnips, when they stand for seed, suck and impoverish the ground exceedingly; for though they are of a cold constitution, and consequently consume less food than plants of a hotter constitution, and of the same bulk, yet, these seed-turnips being so vast a bulk, as sometimes eighty quarters of their roots grow on an acre, and their stalks have been measured seven feet high; and the roots having continued at near their full bigness, for about ten months together, and then carried off, they drain the land more than a crop of other vegetables of less bulk and a hotter constitution, which live a less time; or than wheat, which, though it lives as long, is very small, except in the four last months.

the earth close to the rows in a field of extraordinary large turnips designed for seed. This earth was neglected to be thrown back to the rows until a severe frost in the winter came and killed the turnips; upon which, in the spring the field was sown with barley upon the level with only once ploughing, and that crosswise of the rows. The turnips had stood so wide asunder, that the spot whereon each had rotted appeared like the spot whereon a horse had urined in tilled ground, and was of a deeper colour and much higher than the barley that grew round those spots, and yet none of it was poor. As the roots of clover and St.-Foin are very much less, yet the greater number rotting in ploughed ground must be of great use to a following crop of corn.

I will here relate two examples of this in St.-Foin; the one is, that a field of twenty-five acres drilled with St.-Foin except three acres in the middle of it, which was at the same time sown with hop-clover; after eight years the whole field was plowed up by a tenant, and sown with corn: the St.-Foin had been mowed yearly as the hop-clover was not mowed at all, but fed by horses teddered (or staked) thereon the first and second years, and after that had nothing on it but poor natural grass.

The whole field was managed alike when ploughed up; but the three acres produced visibly worse crops of corn than the rest all round it, which had produced St.-Foin.

The other example, or instance, was, where an acre, part of a field, was, by a fancy, drilled with St.-Foin in single rows, about 33 inches asunder, but was never hoed: after seven years it was ploughed up with the rest of the field across the rows, and sown with oats upon the back three months after ploughing. These rows were as visible in the oats as if the St.-Foin had been still remaining there. The oats in the rows where the St.-Foin had been, looked of a deep green flourishing colour at first coming up, and until they were about half

a foot high, and the spaces between them looked yellowish ; but afterwards the difference of their colour disappeared, all the crop being very good. Upon this I imputed it to the rotting of the roots, which by their singleness were very large ; and when the different colours disappeared, I suppose the roots of all the oats had reached to the benefit of the rotted roots, which might also be then spread further into the spaces, and I doubt not but that the rotting of broad clover-roots has the same effect as of St.-Foin, for manuring of land, especially when the roots are large.

The under-earth, in some time, is replenished by what the rains leave, when they sink through it ; and then tap-rooted plants may be there nourished again, though the upper-earth be drained by the corn ; so that no change is so beneficial, as that betwixt tap-rooted plants, and those which have only horizontal ones. The former are provided for by rains, though not so speedily as the latter are by tillage and hoeing.

Pasture requires no change of herbs ; because they have annually the same supply of food from the dunging of cattle that feed on them, and from the benefit of the atmosphere.

Meadows hold out without change of species of grass, though a crop be carried off every year ; the richness of that soil with the help of the atmosphere, dung of cattle in feeding the after-crop, or else flooding, from the overflowing of some river, some, or all of which, supply the place of the plough to a meadow.

Woods also hold out beyond memory or tradition, without changing sorts of trees ; and this by the leaves, and, perhaps, old wood rotting on the soil annually, which operate as a manure, because, as has been said, earth which has once passed any vessels, is so changed, that for a long time after it does not regain its homogeneity* so much as to mix with pure

* Not that the particles of earth are strictly homogeneous, but that they

earth, without fermenting; and by the descent of the atmosphere, the trees shadowing the soil, to prevent the re-ascent of what that brings down; all this resembling tillage, continually divides the soil, and renews the food equal to the consumption of it made by the wood.

And the last argument I shall attempt to bring for confirmation of all I have advanced, is, that which proves the truth and use of the rest, viz., that when any sort of vegetable, by the due degrees of heat and moisture it requires, is agreeable to a soil, it may, by the new horse-hoeing husbandry, be continued without ever changing the species.

are much less heterogeneous before they are altered by vessels, than afterwards.

CHAPTER XVII.

OF CHANGE OF INDIVIDUALS.

SEEDS, in their natural climate, do not degenerate, unless culture has improved them; and then, upon omission of that culture, they return to their first natural state.

As the benefit of changing species of seeds is from difference of tillage, so the benefit of changing individuals of the same species appears to be from those causes, which are, generally, themselves the effects of different climates; such as heat and moisture, which may also vary very much in the same latitude and neighbourhood; as the same mountain, in the country of the Mogul (related by Mr. Evelyn, from Monsieur Bernier), on the south side, produces Indian plants, and on the north side European plants, from different exposures; and some land retaining water longer, is colder; some suffering it to pass down quicker, and by the nature and figure of its parts causes such a refraction and reflection of the sun's rays, which give a great warmth, as in sand and gravelly grounds that are well situate, and have an under-stratum of some sort of hollow matter, next under the staple, or upper-stratum, wherein the plough is exercised.

This hollow matter lets the water pass down the sooner from the surface, whereby the staple of the ground becomes the drier, and consequently warmer.

This beneficial change of individuals seems rather to be from the forementioned causes than from change of food: and these causes show their efficacy, chiefly in the generation, or foetation of those seeds; as flax-seed brought

from Holland, and sown here, will bring as fine flax as there; but the very next generation of it coarser, and so, degenerating gradually, after two or three descents becomes no better than the common ordinary sort; yet its food is the same, when the flax is fine, as when it is coarse.

And so it is when individuals of wheat are changed; so silk-worms, hatched and bred in France, of eggs or seed, brought from Italy, will make as fine silk as the Italian; but the eggs of these lain in France, and their issue, will make no better silk than the French; though their food be from leaves of the same mulberry-trees, when they make fine silk and coarse; therefore it is from the climate where the eggs are impregnated, not where they have their incubation or food when hatched and fed to their lives' end, that this difference happens.

Common barley sown once in the burning sand, at Patney in Wiltshire, will, for many years after, if sown on different warm ground, be ripe two or three weeks sooner than any other, which has never been impregnate at Patney: but if sown a degree further north, on cold, clayey land, will, in two or three years, lose this quality, and become as late ripe as any other.

Barley is far from being improved by becoming rath-ripe; for it loses more good qualities than it gets by being sown at Patney; it is so tender that if it be sown early the frost is apt to kill it; or if it be sown late in May on the same day, and in the same soil with the same sort of barley that is not rath-ripe, it will be much thinner bodied than the late ripe; and besides, if it happens to have any check by cold or drought, it never recovers it as the other doth, at what time soever it is sown. It is now, as I am informed, gone out of fashion, and very few farmers have sown it of late years. I know a little parish that I believe formerly lost about 200*l*. per ann. by sowing rath-ripe barley; but long and dear experience hath now

convinced them of their error, and obliged them totally to disuse it.

Indeed, Patney is far from improving the species of barley, except we think it improved by becoming more weak and tender, and shorter lived ; which last-mentioned quality fits it for such countries, where the summers are too short for other barley to ripen.

The grains, or seeds of vegetables, are their eggs, and the individual plants immediately proceeding from them, have not only the virtues they received in embryo (or rather in *plantulis*), but the diseases also ; for when smutty wheat is sown, unless the year prove very favourable, the crop will be smutty ; which is an evident token of *mala stamina*.

The smutty grains will not grow, for they turn to a black powder ; but when some of these are in a crop, then, to be sure, many of the rest are infected ; and the disease will show itself in the next generation, or descent of it ; if the year wherein it is planted prove a wet one.

Weeds, and their seed, in the fields where they grow naturally, for time immemorial, come to as great perfection as ever, without change of soil.

These weeds, with acorns, and other masts, crabs, sloes, hips, and haws, are thought to have been, originally, the only natural product of our climate ; therefore, other plants being exotics, many of them, as to their individuals, require culture, and change of soil, without which they are liable, more or less, to degenerate.

Equivocus, like his lower class of readers, which he describes, is unable or unwilling to distinguish the difference of change of a species of plants, from the change of its individuals ; when he pretends to bring as an argument the degenerating of the individuals of beans, &c., to prove the necessity of changing the species of them.

But to say, that the soil can cause wheat to degenerate

into rye, or convert rye into wheat, is what reflects upon the credit of Laurembergius: it is as easy to believe, that a horse, by feeding in a certain pasture, will degenerate into a bull, and in other pasture revert to a horse again; these are scarce of more different species than wheat and rye are: if the different soil of Wittemberg, and Thuringia, change one species, they may the other.

Equivocus, fond of every thing that has no foundation of truth, asserts, "that barley will degenerate into bigg," which is a very different species: and yet he doth not own from whence he stole this wonderful discovery.

CHAPTER XVIII.

OF RIDGES.

THE method of ploughing land up into ridges, is a particular sort of tillage; the chief use of which is the alteration it makes in the degrees of heat and moisture, being two of the grand requisites of vegetation; for very different degrees of these are necessary to different species of vegetables.

Those vegetables commonly sown in our fields, require a middle degree of both, not being able to live on the sides of perpendicular walls in hot countries, nor under water in cold ones, neither are they amphibious, but must have a surface of earth not covered, nor much soaked with water, which deprives them of their necessary degree of heat, and causes them to languish. The symptoms of their disease are a pale or yellow colour in their leaves, and a cessation of growth, and death ensues as sure as from a dropsy.

The only remedy to prevent this disease in plants, is to lay such wet land up into ridges, that the water may run off into the furrows, and be conveyed by ditches or drains into some river.

The more a soil is filled with water, the less heat it will have.

The two sorts of land most liable to be over-glutted with water, are hills, whereof the upper stratum (or staple) is mould lying upon a second stratum of clay. And generally all strong deep land.

Hills are made wet and spewy by the rain-water which falls thereon, and soaks into them as into other land; but being stopped by the clay lying next the surface or staple, cannot enter the clay; and, for want of entrance, spreads

itself upon it ; and as water naturally tends downwards, it is, by the incumbent mould, partly stopped in its descent, from the upper, towards the lower side of an hill ; and being followed and pressed on by more water from above, is forced to rise up into the mould lying upon it, which it fills as a cistern does a fountain (or *jette d'eau*). The land of such a hill is not the less wet or spewy for being laid up in ridges, if they be made from the higher to the lower part of the field ; for the force of the water's weight continued, will raise it so, as to cause it to issue out at the very tops of those ridges : the earth becomes a sort of pap or batter, and being like a quagmire, in going over it, the feet of men and cattle sink in till they come to the clay ; the upper mould is near the condition of the *chaos instabilis terra*.

There are two methods of draining such a wet hill : the one is to dig many trenches across the hill horizontally, and either fill them up with stones, loose or arch-wise, through which the water, when it soaks into the trenches, may run off at one or both ends of them into some ditch which is lower, and carries it away : then they cover the trenches with mould, and plough over them as in dry level ground.

For if they are made with the descent, and not across it, then they will be parallel to the rills of water that run upon the surface of the clay under the staple (or upper stratum of mould) and would be no more effectual for draining the hill, than the digging of one river parallel to another, without joining it in any part, would be effectual for draining the other river of its water.

This method has been found effectual for a time, but not of long continuance ; for the trenches are apt to be stopped up, and then the springs break out again as before ; besides, this is a very chargeable work, and in many places the expense of it may almost equal the purchase of the land.

Therefore it is a better method to plough the ridges across the hill, almost horizontally, that their parting furrows lying

open, may each serve as a drain to the ridge next below it ; for when the plough has made the bottom of these horizontal furrows a few inches deeper than the surface of the clay, the water will run to their ends, very securely, without rising into the mould, provided no part of the furrows be lower than their ends.

These parting furrows, and their ridges, must be made more or less oblique, according to the form and declivity of the hill ; but the more horizontal they are, the sooner the rain-water will run off the lands ; for in that case it will run to the furrows, and reach them at right angles, which it will not do when the ridges (of lands) are oblique ; and therefore the water's course across the lands will be longer. Every one of these horizontal trenches receives all the water from the rills or little gutters wherein the water runs betwixt the mould and the clay ; these are all cut off by the trenches, which receive the water at their upper sides, and carry it away, as the trunks of lead placed under the eaves of a house do carry away the rain-water.

The natural course of water being downwards, it would always run by the nearest way to the bottom of the hill, if nothing stopped it ; but the water runs from a hill in two manners, viz., upon the surface of the staple, and upon the surface of the clay that is under the staple : that which runs under keeps its straight course from the top to the bottom of a hill, under a ridge that is made exactly with the descent of the hill, except that part of the water that rises up into the mould, and a very little that soaks into the furrows ; for when the furrows are not made exactly with the descent, the more oblique they are to the descent, the longer will be the water's course under the ridges ; and the shorter, as they are nearer being at right angles to the descent. It is also the same with the water that falls upon the surface of the ridges, for the more horizontal they are, the shorter its course will be from them to the furrows which carry it off ; and the less

of the water will sink into the ridges, the less oblique and the nearer to right angles to the descent they are made.

If there were no other manner of ploughing ridges on the sides of hills than what is commonly practised on the plains, this method of leaving open furrows (or drains on declivities) would be impracticable; because the plough could not turn up the furrows against the hill, and against the ridge also, from the lower side of it: but the easy remedy against that inconvenience is, to plough such ridges in pairs, without throwing any earth into the trenches, and then the ridges will be plain at top, and the rain-water will run speedily downward to the next trench, and thence to the head-land, and so out of the field. These trenches will be made, as well as kept, always open, by this ploughing in pairs, and is abundantly more easy than the way of ploughing ridges singly. This ploughing in pairs prevents also another inconveniency, which would otherwise happen to these horizontal ridges; and that is, they being highest in the middle, the rain-water could not run freely from the upper half of a ridge towards the next furrow below it, but would be apt to sink in there, and soak through the ridge; but when ridges lie in pairs, the water will run off from a whole ridge, as well as off the lower half of a ridge that is ploughed singly, and highest in the middle.

Note, that every time of ploughing, the pairs must be changed, so that the furrow, which had two lands (or ridges) turned towards it one time, must have two turned from it the next time: this method keeps the surfaces of all the ridges (or lands) pretty near even*.

Farmers are at more trouble and pains to drown such land

* Note, this cannot be done on a hill, whose declivity is so great, that the plough is not able to turn a furrow against it. But in this case, perhaps, it may be sufficient to plough the ridges obliquely, enough for the furrow to be turned both ways.

(it being common to break their horses' wind in ploughing up hill) than they would be at, if they laid their ridges in the abovesaid manner, which would effectually make them dry. Many hundred acres of good ground are spoiled; and many a good horse, in ploughing against the hill, and against all reason, demonstration, and experience too, which might be learned even from the Irish, who drain their bogs and make them fruitful, whilst some English bestow much labour to drown and make barren many of their hills, which would more easily be made dry and fertile.

I have observed, that those places of such a hill, that when ploughed with the descent were the wettest, and never produced any thing that was sown on them, became the very richest, when made dry by ploughing across the descent. This shows that water does not impoverish land, but the contrary; though, whilst it stands thereon, it prevents the heat which is necessary to the production of most sorts of vegetables: and where it runs swiftly, it carries much earth away with it; where it runs slowly, it deposits, and leaves much behind it.

Though, in all places where this way of making the ridges across the descent of hills is practised, the land becomes dry, yet very few farmers will alter their old method; no, not even to try the experiment; but still complain their ground is so wet and spewy, that it brings them little or no profit: and if the year prove moist, they are great losers by sowing it*.

Of such force is that precept of Virgil's, *Cultusque, ha-*

* Remember, in making ridges of all sorts, and of whatsoever figure the piece is, that no ridge ought to have any more furrows at one end, than at the other end; for if there be, the plough must be turned in the middle of the piece, which will cause the land to be trodden by the horses; but if each end have an equal number of furrows, the horses, in turning, will tread only upon the head-lands, which may be ploughed afterwards; or if designed to be horse-hoed, the head-lands should be narrow, and not ploughed at all.

bitusque, locorum (prædiscere), that seldom is the prejudice of it removed by reason: but some of late are convinced, by observing that a hill of mine has been made dry by this means for fourteen years past, which before was always more wet and spewy than any field in the neighbourhood, and from the time of enclosing it out of a heath (or common) and the converting it to arable, which was about seventy years ago, it had been reputed as little better than barren, on account of its wetness; and that it has been the most profitable field of my farm ever since it has been under this new management. I have also another field that lies about a mile and a half from me; it doth not belong to the farm where I live, but was thrown upon my hands, no tenant caring to rent it, because great part of it was full of springs and barren; this also having been kept in lands ploughed across the descent (which is but a small declivity) is become dry: and now the most prejudiced farmers agree, that keeping the lands or ridges of wet ground always cross the descent doth cure its spewyness. Hereupon some have attempted to put this method in practice on their wet land, and after it had been well tilled up hill and down, have ploughed it the last time for sowing of wheat, in flat lands across the descent; but, by mismanagement, their furrows are higher at each end than the middle, so that none of the water can run off either downwards or sideways, or any other way.

Had the furrows carried off the water at both or either of their ends, it might have been effectual, notwithstanding the broad lands, because their ground hath a much less declivity, and is much less spewy than my hill was: they will doubtless find their mistake and amend it, having a precedent before their eyes; but, if they had none within their own inspection, I question whether this mismanagement might not discourage them from prosecuting their project any further.

The benefit of laying up strong deep land into ridges, is

very great; though there be no springs in it, as are in the hills aforementioned.

This land, when it lies flat, and is ploughed in the Virgilian manner, sometimes one way, sometimes the other, by cross-ploughing, retains the rain-water a long time soaking into it; by that misfortune, the plough is kept out two or three weeks longer than if the same were in round ridges; nay, sometimes its flatness keeps it from drying till the season of ploughing, and even of sowing too, be lost.

The reasons commonly given against such ridges, are these following:

I. They prevent the fancied benefit of cross ploughing.

II. Farmers think they lose part of their ground, by leaving more furrows betwixt ridges than when they lay their land flat, where the lands are made much larger than round ridges can conveniently be: and because, also, the furrows betwixt ridges must be broader, and lie open; but the other they fill up by the harrows.

The first of these I have already answered elsewhere, by showing, that cross-ploughing is oftener injurious than beneficial.

The second, I shall sufficiently confute, if I can make it appear that no ground is lost, but much may be gained, by ridges.

What I mean by gaining of ground, is the increasing of the earth's surface; for if a flat piece be ploughed into ridges, and if in each sixteen feet breadth there be an empty furrow of two feet, and yet by the height and roundness of the ridges, they have eighteen feet of surface, capable of producing corn equally to eighteen feet, whilst the piece was flat, there will be one-eighth part of profitable ground, or surface, gained more than it had when level; and this, I believe, experience will prove, if the thing were well examined into.

But against this increase of profitable ground there is an

objection which I must not call a frivolous one, in respect to the authors who bring it; yet I hope the desire of finding the truth, will justify me to examine it, and the arguments brought to sustain it.

This opinion of theirs is founded upon their notion (which I think very erroneous) of the perpendicular growth of vegetables, and is, by Mr. Bradley, set in its best light, in his Volume I. page 8, *usque ad* page 13, and in his cuts, representing three hills; but his arguments seem to be such as all arguments are which pretend to prove a thing to be what it is not, viz., sophistical ones.

The hypothesis he endeavours to prove, is in page 8, thus :
“ A hill may contain four equal sides, which meet in a point
“ at the top; but the contents of these four sides can produce
“ no more, either of grain or trees, than the plain ground
“ upon which the hill stands or has its base; and yet by the
“ measure of the sides, we find twice the number of acres,
“ roods, and poles, which measures in the base or ground-
“ plot; and therefore, page 9, hills are worth no more than
“ half their superficial measure, *i. e.*, two acres upon the side
“ of the hill to pay as much as one upon the plain, provided
“ the soil of both is equally rich.”

To prove it he gives an example in figure 3, of buildings upon a hill; showing that the two sides of the hill will only bear the same number of houses that may stand in the line at the base.

This is foreign to the question of how much grain or how many trees the hill will produce. For vegetables being fed by the earth, require much more of its surface to nourish them than is necessary for them to stand on; but buildings require no more of the surface but room to stand on; therefore, no such argument, taken from buildings, can be applied to vegetables.

This argument of Mr. Bradley's gives no more satisfaction

to the question about producing of vegetables, than a grazier would do, being asked how many oxen a certain pasture-ground would maintain, if he should answer, by satisfying you with the number of churches which might stand thereon.

The like answer, in effect, may be given to the argument in Fig. IV. of the pales, only he has forgot to show, that to mound over the hill would require double the rails, or double the hedge-wood (except stakes) as to mound the base; if it did not, the hill would be yet of the more value, because thereon more surface might be fenced in at less expense.

In Fig. II. he gives no good reason why the hill should not bear twice the number of trees as the base can do; for there is as much room for two hundred trees on the hill, as for one hundred on the base, because he allows the surface to be double to that of the base. He ought to measure the distances of the trees on the hill, by a line parallel to the surface they grow on, as well as he does the distances of those below.

And suppose the row at the base, together with the surface they grow on, were raised up so that it should become parallel to half the row on the hill, would not the trees in the base row be twice as near to one another as the trees in the hill row are? And suppose a line had been tied from the tops of all the lower trees before the row was so raised up at one end, and then, after the situation of the row was so altered, if by this line the trees should be pulled from being perpendicular to the surface they grow on, and made to stand oblique to that, and perpendicular to the horizon, as the upper trees are, would the distances of the trees from one another be altered by this change of posture? No; for their bottoms would be at the same distances, because not removed; and their tops, because the same line holds them, at the same distances in both postures.

Mr. Bradley's lines, drawn from the trees below, which are one perch asunder, make the two rows of trees, falsely,

seem to be at equal distances, because these lines are parallel to each other: but this is a deceit; for in truth, the distances of the trees are not measured by the distances of those lines, but by the extreme points at the ends of the lines*; and those two points above, where the lines cut the row obliquely, and at unequal angles, are twice as far asunder as the endmost or extreme points below are, where the lines cut the row at right angles. Hence may be inferred that there is room for twice as many trees to grow on the hill as on the base, and twice as much grain, for the same reason, and because there is twice the surface for the roots to spread in. And since Mr. Bradley allows the hill to contain two perches to one of the base, and the soil of both to be of equal goodness, and yet affirms, that the two can produce no more of grain or trees than the one perch can, I cannot see why it should not be as reasonable to say, that two quarters of oats will maintain a horse no longer, nor better, than one quarter of oats, of equal goodness, will do.

In page 13, he concludes thus: "That hills, in their measure, contain only as much profitable land as the plain or plot of ground they stand upon; and as a proof of that, all vegetables or plants have an erect method of growth."

This proof of Mr. Bradley's is founded upon an argument which has no consequence, unless it were first proved that the surface of earth could produce and maintain as many vegetables or plants as could stand thereon in an erect posture; which supposition is as impossible, as that half an acre should produce and maintain a hecatomb, without Mr. Bradley's teaching oxen to live upon air for their food, as he thinks Van Helmont's tree did.

* These upper trees are measured by the unequal length of the lines, not by their parallel distance, as the lower trees are; therefore his measure is a quibble.

All expert husbandmen must needs be convinced, that the greatest crop of vegetables that ever grew, might stand in an erect posture, upon a twentieth (and I may say the hundredth) part of the surface that produced it; therefore, there must be nineteen parts (for the roots to spread) unoccupied by the trunks, stems, or stalks.

And though it be true, that a hill will support no more of these (than its base) when placed in an erect posture close together, as in a sheaf; yet this close position is only proper for them when they are dead, and require no more nourishment than houses and pales do; and consequently require no room but to stand on. Therefore, this argument of Mr. Bradley's must not be admitted in vegetative growth, where there is always required nineteen times more room in the surface, for the use of the roots, than what the stems, trunks, or stalks, do possess upon it; and the more room there is for the roots, the greater number of plants may be produced.

Neither can I admit, that all vegetables or plants have an erect method of growth; because the contrary is seen in camomile, and divers other vegetables, which have an horizontal method of growth.

But what is more material to this purpose, to be observed, is, that all vegetables have horizontal roots, and roots parallel to the earth's surface or superficies; and unless those roots have a sufficient superficies of earth to range in, for nourishment of a plant, the stem and branches cannot prosper, whatever be their method of growth above the earth; and if there be not a due quantity of food for the roots, within the earth, a very little space may contain the external parts of vegetables upon it.

From what has been said, I think we may conclude, that Mr. Bradley's hill may produce more vegetables than the base whereon it stands; and, therefore, it is of more value

than half its superficial measure, *i. e.*, two acres on the hill is worth more than one acre on the plain, the soil being equally rich, as he allows it to be, in his case.

Now, indeed, whether Mr. Bradley might not possibly be deceived in his opinion, of the equal richness of his hill and his plain, I will not dispute; I will only say this, that it is generally otherwise. But where a plain is ploughed up into moderate ridges, their height being in proportion to the depth of the staple, below which the plough must take nothing into the ridges, the soil is equally rich, whether it be ploughed plain or ridged up. And, as the surface is in the ridges increased, there is nothing, in all Mr. Bradley's arguments, that shows, why that increased surface should not produce more vegetables than the same earth could do whilst it was level.

There are other reasons why it should produce more when ridged, besides the increase of surface; as,

I. It is then more free from the injuries of too much water.

II. It is better protected against cold winds; because the ridges are a shelter to one another.

III. If the surface be much exhausted, by too frequent sowing, the ridges may be made just where the furrows were, and then the surface will be entirely changed.

To the three we may add a fourth reason, *viz.*, the raising the thickness of the staple in the ridges, keeping the surface drier in wet weather, and moister at the bottom of the staple in dry weather. And I have seen barley that was drilled on my raised little ridges flourish in a dry summer on the brow of my chalky hill, and on my lowest land in wet weather when the barley hand-sown contiguous to it on each side those ridges, sown on the level the same day that the ridges were drilled, have looked yellow and sickly, and yet it is not wet land.

The following general rules ought to be observed about ridges, viz.,

That as to their height, regard must be had to the nature of the soil, in its difficult admission of water; for the greater that is, the greater declivities the ridges should have; and then, if the soil be not deep, they should generally be made the narrower.

There is one thing which Mr. Bradley takes no notice of, viz., that no more of the rain, or other benefits of the atmosphere, which descend perpendicularly, can fall on a hill, or on a ridge, than what would fall on the base, or ground-plot. But, it is probable, that more of the fine vapour, which swims in the current of the air horizontally, does strike and break against those eminences, and so make an equivalent*; except that it runs off more quickly.

Notwithstanding all I have here said, in behalf of ridges, I must confess, that for my hoeing-husbandry, I should prefer land that is naturally dry enough, without a necessity of being laid up in any larger or higher ridges than what may contain six feet in breadth, that size being the largest that is proper for the regular operation of the horse-hoe; whether the rows be double, triple, or quadruple.

Since the printing of my Essay, I find upon trial that these narrow ridges are as effectual as any for carrying the water off from my clayey hill; and that they may be made much less horizontal than broad ridges, whereby their furrows are the more easily turned upwards against the declivity.

I have not tried any narrower ridges than of six feet, upon this hill; but I have had full experience of five feet and of

* But though ridges do alter or increase the surface, the quantity of soil or earth remaining the same as on the level, and of no greater depth than can be tilled, it may produce equal crops of corn with the level, and no more; except from the advantages the ridges may give it in lying drier.

four feet ridges upon other land, and find that all sizes of these narrow ridges are very advantageous even where the crop is to be sown upon the level; for fewer furrows are necessary for the tilling of an acre, when it is kept in such ridges, than in broad lands, and after wet weather the ridges will be fit to be ploughed much sooner than level ground.

CHAPTER XIX.

OF DIFFERENCES BETWEEN THE OLD AND THE NEW HUSBANDRY*.

IN order to make a comparison between the hoeing husbandry, and the old way, there are four things ; whereof the differences ought to be very well considered.

- | | |
|---|--------------|
| I. The expense | } of a crop. |
| II. The goodness | |
| III. The certainty | |
| IV. The condition in which the land is left after a crop. | |

The profit or loss arising from land, is not to be computed, only, from the value of the crop it produces, but from its value, after all expenses of seed, tillage, &c., are deducted.

Thus, when an acre brings a crop worth four pounds, and the expenses thereof amount to five pounds, the owner's loss is one pound ; and when an acre brings a crop which yields thirty shillings, and the expense amounts to no more than ten shillings, the owner receives one pound clear profit from this acre's very small crop, as the other loses one pound by his greater crop.

The usual expenses of an acre of wheat, sown in the old husbandry, in the country where I live, is, in some places,

* I do not say that every species of old husbandry is Virgilian ; for when land of all sorts is ploughed five or six times with due intermissions, instead of once or twice, in that respect it is rather Anti-Virgilian ; though it is not the horse-hoeing method, which I call the new husbandry, because not practised but for about these fourteen last years, that I know of.

for two bushels and a half of seed; in other places four bushels and a half; the least of these quantities at three shillings per bushel, being the present price, is seven shillings and sixpence. For three ploughings, harrowing, and sowing, sixteen shillings; but if ploughed four times, which is better, one pound. For thirty load of dung, to a statute acre, is two pounds, five shillings. For carriage of the dung, according to the distance, from two shillings to sixpence the load; one shilling being the price most common, is one pound ten shillings. The price for weeding is very uncertain, it has sometimes cost twelve shillings, sometimes two shillings per acre.

	£	s.	d.
In Seed and Tillage, nothing can be abated of	1	3	6
For the Weeding, one year with another, is more than	0	2	0
For the Rent of the year's fallow	0	10	0
For the Dung; it is in some places a little cheaper, neither do they always lay on quite so much; there- fore abating fifteen shillings in that article, we may well set dung and carriage at	2	10	0
Reaping commonly five shillings, sometimes less	0	4	6
Total	4	10	0

The price of dung is different in different places, and the price of carriage varies according to the distance. It would cost me much more than fifty shillings to buy dung and hire the carriage of it for an acre; and in many places the expense of it is greater yet, though Equivocus is pleased to set it from forty shillings to forty-four shillings for an acre. Yet, in his Essay for June, p. 61, he sets dung at two shillings a load, and then thirty load to an acre, which are commonly laid, and thirty shillings for carriage, and spreading makes the expense of dunging an acre amount to four pounds ten shillings; and yet he says, that in a dry summer dung may burn up and spoil the crop.

Were I to buy dung at the nearest place where any is to be sold, the very carriage of it to my land would be worth above five pounds for each acre.

Equivocus, in his Essay for May, p. 228, says, land that had been the most dunged brought the worst crop of corn.

He says, the dung being for two years, ought to be reckoned but half of it to the first year. In answer to this, I say, that though it may be, as he alleges, in the common husbandry, yet in this comparative calculation, the whole expense of dung must be charged to the first year; because a crop sown in the common manner upon the level, the next year after a hoed crop without dung, is always as good or better than when sowed the next year after a dunged sown crop.

Folding of land with sheep is reckoned abundantly cheaper than cart-dung; but this is to be questioned, because much land must lie still for keeping a flock (unless there be downs) and for their whole year's keeping with both grass and hay, there are but three months of the twelve wherein the fold is of any considerable value; this makes the price of their manure quadruple to what it would be, if equally good all the year, like cart-dung: and folding sheep yield little profit, besides their dung; because the wool of a flock, except it be a large one, will scarce pay the shepherd and the shearers. But there is another thing yet, which more enhances the price of sheep dung; and that is, the dunging the land with their bodies, when they all die of the rot, which happens too frequently in many places; and then the whole crop of corn must go to purchase another flock, which may have the same fate the ensuing year, if the summer prove wet. And so may the farmer be served for several more successive years, unless he should break, and another take his place, or that dry summers come in time to prevent it. To avoid this misfortune, he would be glad to purchase cart-dung at the highest price, for supplying the

place of his fold ; but it is only near cities, and great towns, that a sufficient quantity can be procured.

But, supposing the price of dunging to be only two pounds ten shillings, and the general expense of an acre of wheat, when sown, as three shillings per bushel, to be four pounds ten shillings, with the year's rent of the fallow.

The expenses of planting an acre of wheat in the hoeing husbandry, is three pecks* of seed, at three shillings per bushel, is two shillings and threepence. The whole tillage, if done by horses, would be eight shillings ; because our two ploughings and six hoeings†, are equal to two stirrings, the common price whereof is four shillings each ; but this we diminish half, when done by oxen kept on St.-Foin, in this manner, viz., land, worth thirty shillings rent, drilled with St.-Foin, will well maintain an ox a year‡, and sometimes hay will be left to pay for the making ; we cannot, therefore, allow more than one shilling a-week for his work, because his keeping comes but to sevenpence a-week round the year.

In plain ploughing, six feet contains eight furrows ; but we plough a six-foot ridge at four furrows, because in this there are two furrows covered in the middle of it, and one on

* Sometimes half a bushel is the most just quantity of seed to drill on an acre.

† But we sometimes plough out six-foot ridges before drilling, at five or six furrows, which is a furrow or two more than I have reckoned ; but we do not always hoe six times afterwards.

But it is better for successive wheat-crops to bestow the labour of as many hoeings as amount to three plain ploughings in a year, it being a greater damage to omit one necessary hoeing, than is the expense of several hoeings.

‡ Or an ox may be well kept nine months, with an acre of indifferent horse-hoed turnips ; and if we value them only at the expense and rent of the land, this will be a yet cheaper way of maintaining oxen.

Upon more experience, it is found that St.-Foin hay alone, or with a small quantity of turnips, is best for working oxen in the winter ; but a plenty of turnips with the same hay is better for fatting oxen that do not work.

each side of it lies open. Now, what we call one hoeing, is only two furrows of this ridge, which is equal to a fourth part of one plain ploughing; so that the hoeing of four acres requires an equal number of furrows with one acre, that is ploughed plain, and equal time to do it in (except that the land that is kept in hoeing, works much easier than that which is not).

All the tillage we ever bestow upon a crop of wheat that follows a hoed crop, is equal to eight hoeings, two of which may require four oxen each, one of them three oxen, and the other five hoeings two oxen each. However, allowing three oxen to each single hoeing, taking them all one with another, which is three oxen more than it comes to in the whole.

But the number of oxen required will be according to their bigness and strength, and to the depth and strength of the soil, which also will be the easier draught for the oxen, the oftener the intervals are hoed.

Begin at five in the morning; and in about six hours you may hoe three acres, being equal in furrows to three rood, *i. e.*, three quarters of an acre. Then turn the oxen to grass, and after resting, eating, and drinking two hours and a half, with another set of oxen begin hoeing again; and by, or before, half an hour after seven at night, another like quantity may be hoed. These are the hours the statute has appointed all labourers to work, during the summer half-year.

This is the time limited by the words of the statute; but the meaning is to be determined by the unlimited magistrates, who are to put the same in execution; and some of them (and their determination has the same effect as of all) have lately declared, that if a labourer works an hour, he must be paid for a day, which makes some alteration in the price of tillage of all sorts.

To hoe these six acres a day, each set of oxen draw the

plough only eight miles and a quarter, which they may very well do in five hours; and then the holder and driver will be at their work of ploughing ten hours, and will have four hours and a half to rest, &c.

The expense then of hoeing six acres in a day, in this manner, may be accounted at one shilling the man that holds the plough, sixpence the boy that drives the plough, one shilling for the six oxen, and sixpence for keeping the tackle in repair. The whole sum for hoeing these six acres is three shillings, being sixpence per acre*.

They who follow the old husbandry cannot keep oxen so cheap, because they can do nothing without the fold, and store-sheep will spoil the St.-Foin. They may almost as well keep foxes and geese together, as store-sheep and good

* But where there is not the convenience of keeping oxen, the hiring price for hoeing with horses is one shilling each time.

And there is no such conveniency in a farm that consists in common field arable-land, without meadow or pasture; nor on such a dry, chalky hill-farm as mine is, without a competent quantity of St.-Foin, nor unless the other part of it, which is kept in arable, be managed without folding sheep, because these will spoil the St.-Foin; and therefore Epuivocus is wrong when he says that oxen are equally advantageous to the old and to the new husbandry; for they can be conveniently kept by the new on a farm whereon they cannot be kept in the old husbandry; he himself affirming that oxen cannot be kept without rich pasture-land, of which mine and very many other hill-farms have none at all. But for Equivocus to take from hence an occasion to insinuate, that I pretend to be the inventor of ploughing with oxen, and for him to cite Fitzherbert against me to prove that I am not, and that I ought not to have the honour of broaching it, is most ridiculously shameful in Equivocus, whose only talent is pedantry, and therefore he ought to know that oxen were the first drawers of the plough, since a heathen poet says of Ceres, that she

Prima jugis Tauros supponere colla coegit,
Et veterem curvo dente revellit humum.

When a roller is used, which is less than a hoeing, because one person to lead is enough, and that may be a boy; and once in an interval may suffice, then it is less labour than half a hoeing; and for this we may well abate one hoeing of the eight,

St.-Foin. Besides, the sowed St.-Foin costs ten times as much the planting as drilled St.-Foin does, and must be frequently manured, or else it will soon decay; especially upon all sorts of chalky land, whereon it is most commonly sown.

The expense of drilling cannot be much; for, as we can hoe six acres a-day, at two furrows on each six-foot ridge, so may we drill twenty-four acres a-day, with a drill that plants two of those ridges at once; and this we may reckon three halfpence an acre. But because we find it less trouble to drill single ridges, we will set the drilling, at most, at sixpence per acre.

As every successive crop (if well managed) is more free from weeds than the preceding crop, I will set it altogether at at sixpence* an acre for weeding.

This may be enough, if the land be well cleansed the year before, and considering that several years in such there is no occasion for weeding at all: and as this calculation is comparative with the old way, we should examine the price of weeding the sown corn, which by the best information I can get is, this year, 1735, about 4s. per acre for weeding of barley; and of wheat round about where I live about 6s. and in Wiltshire 15s. per acre for their wheat, amongst which much damage is done by the weeder's feet, and yet some weeds are left.

For a boy or a woman to follow the hoe-plough, to uncover the young wheat, when any clods or earth happen to fall on it, which trouble is seldom necessary above once† to a crop, twopence an acre. One penny is too much for brine and lime for an acre.

* This is when the land has been well cleansed of weeds in the preceding crop, or fallow, or both.

† But this expense being so small, it is better that a person should follow at every hoeing where we suspect that any damage may happen from any earth's falling on, or pressing too hard against, some of the plants.

Reaping this wheat is not worth above half as much as the reaping of a sown crop of equal value ; because the drilled standing upon about a sixth part of the ground, a reaper may cut almost as much of the row at one stroke, as he could at six, if the same stood dispersed all over the ground, as the sowed does. And because he who reaps sowed wheat, must reap the weeds along with the wheat ; but the drilled has no weeds ; and besides, there goes a greater quantity of straw, and more sheaves, to a bushel of the sowed, than of the drilled. And since some hundred acres of drilled wheat has been reaped at two shillings and sixpence per acre, I will count that to be the price.

One sheaf of the latter will yield more wheat than two of the former of equal diameter.

The whole Expense of an Acre of drilled Wheat.				£	s.	d.
For seed	0	2	3			
For tillage	0	4	0			
For drilling	0	0	6			
For weeding	0	0	6			
For uncovering.....	0	0	2			
For brine and lime	0	0	1			
For reaping	0	2	6			
Total				0	10	0
The expense of an acre of sowed wheat is.....				4	0	0
To which must be added, for the year's rent of the fallow				0	10	0
Total				4	10	0

I am wrongfully accused of partiality, by Equivocus, for charging the year's fallow to the calculation of the expenses in the old way, and not to that in the new: when in our successive crops we have no fallow, but in the old there is generally and almost always a fallow for wheat : and therefore two years' rent to be reckoned for their one crop.

If I have reckoned the expense of the drilled at the lowest price, to bring it to an even sum, I have also abated in the

other more than the whole expense of the drilled amounts unto.

And thus the expense of a drilled crop of wheat is but the ninth part of the expense of a crop sown in the common manner.

It is also some advantage, that less stock is required where no store-sheep are used.

II. Of the different goodness of a crop.

The goodness of a crop consists in the quality of it, as well as the quantity; and wheat being the most useful grain, a crop of this is better than a crop of any other corn, and the hoed wheat has larger ears (and a fuller body) than sowed wheat. We can have more of it, because the same land will produce it every year, and even land which, by the old husbandry, would not be made to bear wheat at all: so that, in many places, the new husbandry can raise ten acres of wheat for one that the old can do; because, where land is poor, they sow but a tenth part of it with wheat.

We do not pretend that we have always greater crops, or so great as some sown crops are, especially if those mentioned by Mr. Houghton be not mistaken.

The greatest produce I ever had from a single yard in length, of a double row, was eighteen ounces: the partition of this being six inches, and the interval thirty inches, was, by computation, ten quarters, or eighty bushels to an acre.

I had also twenty ounces to a like yard of a third successive crop of wheat; but this being a triple row, and the partitions and interval being wider, and supposed to be in all six feet, was computed at six quarters to an acre. And if these rows had been better ordered than they were, and the earth richer and more pulverised, more stalks would have tilled out, and more ears would have attained their full size, and have equalled the best, which must have made a much greater crop than either of these were.

But to compare the different profit, we may proceed thus: the rent and expense of a drilled acre being one pound, and of a sowed acre five pounds; one quarter of corn produced by the drilled bears an equal proportion in profit to the one pound, as five quarters produced by the other do to the five pounds. As, suppose it be of wheat, at two shillings and sixpence a bushel, there is neither gain nor loss in the one nor the other acre, though the former yield but one quarter, and the other five; but if the drilled acre yield two quarters, and the sowed acre four quarters, at the same price, the drilled brings the farmer one pound clear profit, and the sown, by its four quarters, brings the other one pound loss. Likewise, suppose the drilling farmer to have his five pounds laid out on five acres of wheat, and the other to have his five pounds laid out on one dunged acre, then, let the wheat they produce be at what price it will, if the five acres have an equal crop to the one acre, the gain or loss must be equal. But when wheat is cheap, as we say it is, when sold at two and sixpence a bushel, then if the Virgilian has five quarters on his acre, he must sell it all to pay his rent and expenses; but the other having five quarters on each of his five acres, the crop of one of them will pay the rent and expenses of all his five acres*, and he may keep the remaining twenty quarters, until he can sell them at five shillings a bushel, which amounts to forty pounds, wherewith he may be able to buy four of his five acres at twenty years' purchase, out of one year's crop, whilst the Virgilian farmer must be content to have only his labour for his travel; or if he pretends to keep his wheat till he sells it at five shillings a bushel, he commonly runs in debt

* Or suppose a drilled acre to produce no more than one-third of the sowed acre's crop, whose expense is five times as much as of the drilled, it is much more profitable, because a third of five pounds, is one pound, thirteen shillings, and fourpence; and a fifth of the rent and expense being only one pound, such drilled acre pays the owner thirteen shillings and fourpence more profit than the other which brings a crop triple to the drilled.

to his neighbours, and in arrear of his rent; and if the markets do not rise in time, or if his crops fail in the interim, his landlord seizes on his stock, and then he knows not how it may be sold, actions are brought against him, the bailiffs and attorneys pull him to pieces; and then the Virgilian farmer is broke†.

III. The certainty of a crop.

The certainty of a crop is much to be regarded, it being better to be secure of a moderate crop, than to have but a mere hazard of a great one. The Virgilian is often deceived in his expectation, when his crop at coming into ear, is very big, as well as when it is in danger of being too little. Our hoeing farmer is much less liable to the hazard of either of those extremes; for when his wheat is big, it is not apt to lodge or fall down, which accident is usually the utter ruin of the other, he is free from the causes which make the Virgilian crop too little.

A very effectual means to prevent the failing of a crop of wheat, is to plough the pulverised earth for seed early, and when it is dry. The early season also is more likely to be dry than the latter season is.

1. The Virgilian is commonly late in his sowing; because he cannot fallow his ground early, for fear of killing the couch, and other grass that maintains his
2. folding sheep, which are so necessary to his husbandry: and when it is sowed
3. late, it must not be sowed dry, for then the winter might kill the young wheat. Neither can he at that time plough dry, and sow wet, because he commonly sows under furrow; that is, sows the seed first, and ploughs it in as fast as it is sown.

† Though only five acres and one acre be put, yet we may imagine them two hundred and fifty; and fifty to enrich the one, or break the other farmer.

4. If he sows early (as he may if he will) in light land, he must not sow dry, for fear the poppies and other weeds should grow and devour his crop; and if his
5. land be strong, let it be sown early, wet or dry (though wet is worst) it is apt to grow so stale and hard by the spring, that his crop is in danger of starving, unless the land be very rich, or much dunged, and then the winter and spring proving kind, it may not be in less danger of being so big as to fall down and be
6. spoiled. Another thing is, that though he had no other impediment against ploughing dry, and sowing wet, it is seldom that he has time to do it in; for he
7. must plough all his ground, which is eight furrows in six feet, and whilst it is wet, must lie still with his plough. When he sows under furrow, he fears to
8. plough deep, lest he bury too much of his seed, and if he ploughs shallow, his crop loses the benefit of deep-ploughing, which is very great. When he sows upon
9. furrow (that is after it is ploughed) he must harrow the ground level to cover the seed, and that exposes the wheat the more to the cold winds, and suffers the snow to be blown off it, and the water to lie longer on it: all which are great injuries to it.

Our hoeing husbandry is different in all of the fore-mentioned particulars.

1. We can plough the two furrows whereon the next crop is to stand, immediately after the present crop is off.

2. We have no use of the fold; because our ground has annually a crop growing on it, and it must lie still a year, if we would fold it, and that crop would be lost; and all the good the fold could do to the land, would be only to help to

pulverise it for one single crop; its benefit not lasting to the second year. And so we should be certain of losing one crop for the very uncertain hopes of procuring one the ensuing year by the fold; when it is manifest, by the adjoining crops, that we can have a much better crop every year, without a fold or any other manure.

3. We can plough dry, and drill wet, without any manner of inconvenience.

4. He fears the weeds will grow and destroy his crops: we hope they will grow, to the end we may destroy them. For before they grow they cannot be killed; but if they are all killed as soon as they appear, there will be no danger of their exhausting the land or restocking it with their seed; and it is our fault if we drill more than we can keep clean from weeds by the horse-hoe, hand-hoe, and hands: the first for the intervals, the second for the partitions, and the third for the rows: by the two former, as soon after they appear as they can; but by the last, when they are grown high enough to be conveniently taken hold of.

5. We do not fear to plant our wheat early (so that we plough dry), because we can help the hardness or staleness of the land by hoeing.

6. The two furrows of every ridge whereon the rows are to be drilled, we plough dry; and if the weather prove wet before these are all finished, we can plough the other two furrows up to them, until it be dry enough to return to our ploughing the first two furrows, and after finishing them, let the weather be wet or dry, we can plough the last two furrows. We can plough our two furrows in the fourth part of the time they can plough their eight, which they must plough dry, all of them, in every six feet; for they cannot plough part dry, and the rest when it is wet, as we can.

7. We never plant our seed under furrow, but place it just

at the depth, which we judge most proper, and that is pretty shallow, about two inches deep, and then there is no danger of burying it.

8. We not only plough a deep furrow, but also plough to the depth of two furrows ; that is, we trench-plough where the land will allow it ; and we have the greatest convenience imaginable for doing this, because there are two of our four furrows always lying open ; and two ploughed furrows (that is, one ploughed under another) are as much more advantageous for the nourishing a crop, as two bushels of oats are better than one for nourishing a horse. Or if the staple of the land be too thin or shallow, we can help it by raising the ridges prepared for the rows the higher above the level.

Very little of my land will admit the plough to go the depth of two common furrows without reaching the chalk ; but deep land may be easily thus trench-ploughed with great advantage ; and even when there is only the depth of a single furrow, that may sometimes be advantageously ploughed at twice.

9. We also raise a high ridge in the middle of each interval above the wheat, before winter, to protect it from the cold winds, and to prevent the snow from being driven away by them. And the furrows or trenches, from whence the earth of these ridges is taken, serve to drain off the water from the wheat, so that it being drier, it must be warmer than the harrowed wheat, which has neither furrows to keep it dry, nor ridges to shelter it, as every row of ours has on both sides of it.

This is a mistake ; for the ridges in the middle of the intervals do not always, nor often in thin shallow land, lie high enough to make a shelter to the rows, they being higher : but when wheat is drilled on the level, it is sheltered by the ridges raised in the intervals : but we never weed or hand-hoe wheat before the spring.

IV. The condition in which the land is left after a crop.

The different condition the land is left in after a crop, by the one and the other husbandry, is not less considerable than the different profit of the crop.

If indifferent land be well pulverised by the plough for one whole year, it will produce a good crop: but then, if, instead of being sown, it be kept pulverised on for another year without being exhausted by any vegetables, it will acquire from the atmosphere an extraordinary great degree of fertility, more than it had before such second year's pulverisation and unexhaustion. This being granted, which no man of experience can deny, what reason can there be why such a number of plants, competent for a profitable crop, may not be maintained on it the second year that may keep the degree of their exhaustion in equilibrio with that degree of fertility, which the same land had acquired at the end of the first year of its pulverisation, the same degree of pulverisation being continued to it by hoeing in the second year? Or why may it not produce annual crops always, if the same equilibrium be continually kept? Two unanswerable reasons may be given, why this equilibrium cannot be kept in the random sowing, as it may in the hoeing method, viz., 1st, in the former, the land is by the number of sown plants and weeds much more (we may suppose at least five times more) exhausted: and, 2dly, no pulverisation is continued to the soil, whilst the crop is on it; which is that part of the year wherein is the most proper (if not the only proper) season for pulverising; therefore, allowing that in the random way a soil cannot, for want of quantity of vegetable food, continue to produce annual crops without manure, or perhaps with it; yet, that is no reason why it may not produce them in the hoeing culture duly performed.

A piece of eleven acres, of a poor, thin, chalky hill, was sown with barley in the common manner, after a hoed crop

of wheat, and produced full five quarters and a half to each acre (reckoning the tithe) which was much more than any land in all the neighbourhood yielded the same year; though some of it be so rich, as that one acre is worth three acres of this land: and no man living can remember that ever this produced above half such a crop before, even when the best of the common management has been bestowed upon it.

A field that is a sort of a heath-ground, used to bring such poor crops of corn, that heretofore the parson carried away a whole crop of oats from it, believing it had been only his tithe. The best management that ever they did or could bestow upon it, was to let it rest two or three years, and then fallow and dung it, and sow it with wheat, next to that with barley and clover, and then let it rest again; but I cannot hear of any good crop that it ever produced by this or any other of their methods; it was still reckoned so poor, that no body cared to rent it. They said dung and labour were thrown away upon it: then immediately after two sown crops of black oats had been taken off it, the last of which was scarce worth the mowing, it was put into the hoeing management, and when three hoed crops* had been taken from it, it was sown with barley, and brought a very good crop, much better than ever it was known to yield before; and then a good crop of hoed wheat succeeded the barley; and then it was again sown with barley, upon the wheat stubble; and that also was better than the barley it used to produce.

Now, all the farmers of the neighbourhood affirm, that it is impossible but that this must be very rich ground, because they have seen it produce six crops in six years, without dung or fallow, and never one of them fail. But, alas! this

* These three hoed crops were of turnips and potatoes.

different reputation they give to the land, does not at all belong to it, but to the different sorts of husbandry; for the nature of it cannot be altered but by that, the crops being all carried off it, and nothing added to supply the substance those crops take from it, except (what Mr. Evelyn calls) the celestial influences, and that these are received by the earth, in proportion to the degrees of its pulverisation.

A field was drilled with barley after a hoed crop, and another adjoining to it on the same side of the same poor hill, and exactly the same sort of land, was drilled with barley also, part of it after the sown crop, the same day with the other; there was only this difference in the soil, that the former of these had no manner of compost on it for many years before, and the latter was dunged the year before, yet its crop was not near so good as that which followed the hoed crop*; though the latter had twice the ploughing that the former had before drilling, and the same hoeings afterwards, viz., each was hoed three times.

A field of about seventeen acres was summer-fallowed, and drilled with wheat, and with the hoeing brought a very good crop (except part of it, which being eaten by trespassing sheep in the winter, was somewhat blighted); the Michaelmas after that was taken off, the same field was drilled again with wheat, upon the stubble of the former, and hoed: this second crop was a good one, scarce any in the neighbourhood better. A piece of wheat adjoining to it, on the very same sort of land (except that this latter was always reckoned better, being thicker in mould above the chalk), sown at the same time on dunged fallows, and the ground always dunged once in three years, yet this crop failed so much, as to be judged, by some farmers, not to exceed the tithe of the other: that the hoed field has received no dung

* This was a wheat crop, and often well hoed.

or manure for many years past, is, because it lies out of the reach for carrying of cart-dung, and no fold being kept on my farm : but, I cannot say I think there was quite so much odds betwixt this second undunged hoed crop and the sown ; yet this is certain, that the former is a good, and the latter a very bad crop.

The reasons why I keep no sheep are many, viz., I have no common, nor downs, nor pasture, nor meadow to keep sheep upon ; and St.-Foin is unfit for store sheep ; so that if I kept a fold I should be obliged to till with horses only, which (according to the rules whereby our servants, at present, are pleased to govern us) would cost me one full rent more than the same tillage done by oxen. The profit of store sheep depends much upon the owner's skill in managing them, in buying and selling them at proper times, and in many other circumstances ; it is a trade that I am not master of, nor can I have it well done by a deputy. I find it very difficult to preserve my corn from being spoiled by neighbouring sheep ; but, if I had a flock of my own, it would be more difficult ; besides the trouble and continual quarrels with neighbours about damages done and received. Thus the same sheep would be detrimental to me that are profitable to others. Then as to the fold, the urine of sheep is a great pulveriser of the soil, and without which the Virgilian can do nothing, nor the common farmer much ; but in the hoeing husbandry, I know, by many years experience, there is no necessity of a fold, as there is not (in such a farm as mine, managed by such an occupier as I am) a conveniency of keeping a fold.

The low price of wool in Britain shows, that more sheep are kept here than are for the public benefit ; the too great plenty of wool being contrary to that of corn, because foreign countries buy our wool to supply their manufactures in prejudice to our own ; and as the French have none of those

statutes, the consequence of which enhances the price of our labour to double, and in some works to quadruple of theirs, they can afford to pay above double the price for wool that our clothiers can, and yet undersell our merchants of cloth in foreign markets; and the more foreigners have from us, the more will they stock those markets with their cloth. We are apt to have too much wool, as appears by the act for burying in woollen, which, because the living are not sufficient to consume it, obliges the dead to wear it.

Equivocus, in his Essay for April, p. 17, affirms, that I say in my Essay, "that even the dung and urine of sheep are of no use in husbandry;" but if the reader cannot find that I have said so, he will be satisfied of the want of veracity Equivocus is guilty of here, as well as in his other false quotations.

Is it not very unfair of Equivocus to represent the farmer's opinion of the odds, as if it were mine, when in the same paragraph I contradict the farmer's opinion? That in my account, I have not exaggerated the odds of those different crops, two of the noble peers, whom Equivocus has had the presumption to name (in p. 64, of his Introduction to April), and several gentlemen, being altogether eye-witnesses of it just before harvest, could with justice vindicate me from the false imputation he would maliciously cast upon me, relating to the *ipse dixit*, which he has falsely quoted. Those two crops grew within two or three horses' length of one another, both on hill ground; mine was formerly a sheep-down, and the other a cow-down, and to this day retains the name of Cow-Down-Hill: the poor crop had not too much dung, nor was it a very dry summer, which I mention in answer to the questions of Equivocus.

I could give many more instances of the same kind, where hoed crops and sown crops have succeeded better after hoed crops than after sown crops, and never yet have seen the

contrary ; and therefore am convinced, that the hoeing (if it be duly performed) enriches the soil more than dung and fallows, and leaves the land in a much better condition for a succeeding crop ; the reason I take to be very obvious. The artificial pasture of plants is made and increased by pulverisation only ; and there is nothing else in our power to enrich our ground, but to pulverise it, and keep it from being exhausted by vegetables*. (Superinductions of earth are an addition of more ground, or changing it, and is more properly purchasing than cultivating.)

This is more especially meant of Virgilian fallows, and a moderate quantity of common dung or the fold : and there may be such a poor sand, or other barrenish soil, so subject to constipation in the winter, as to require dung when planted with wheat, there being no general rule without exceptions ; and it is impossible for me to know the number of these exceptions. Well it is for the hoer, whose land is of such a kind, that he can keep it in heart without dung by hoeing ; for when he has no fold, ploughs his ground with oxen, and plants it mostly with wheat, the straw whereof being for other uses, he can make but very little dung.

I have given reasons for this my opinion ; and as far as the authority of Equivocus goes, he confirms the first part of it ; for in p. 165 of his Essay for August, he gives up the necessity of dung, after all the stir and stench he has made

* It may be asked, how it is possible that eight hoeings, which are but equal, in labour, to two plain ploughings, should so much exceed three plain ploughings, as to procure as good or a better crop without manure, than the common three ploughings can do with manure, and enrich the land also ?

The answer is, that each hoeing of the five or six being done to the wheat-plants, though it does not clean-plough the whole interval underneath, yet it changeth the whole external superficies (or surface) thereof, whereby it becomes impregnate by the nitrous air, as much as if it were all clean-ploughed at the time of every hoeing, and the weeds are as much stifled or suffocated.

of it, and says, "That fallowing twice, and sowing with "turnips, improve land more than dung." And I believe it will appear upon full trials, that our hoeings, duly and frequently performed, may improve more than twice fallowing: because by hoeing the land is fallowed, and many times iterated every year, and if our plants are only a bare competent number, they may exhaust the land less than a crop of sown turnips. All experienced husbandmen (I do not mean such as have practised none but Virgilian) will allow, that a Virgilian fallow (which Equivocus, in p. 124, 125 of his Essay for July relates) is a very mean improver of the land. He here affirms it for a "well-known truth in "husbandry, that wheat should never be sown but upon "ground which has been once or twice ploughed, and has "lain fallow for a whole summer." Indeed the land lying still one summer might not be much exhausted by the wheat sown therein without once or twice ploughing; for it would produce none, or very little.

These two are all we have in our power, for pulverising includes an exposure to the atmosphere, without which, I think, it cannot be reduced to particles minute enough, or have their superficies so impregnated as to become a fertile pasture for plants. The experiment related by Mr. Evelyn of artificial pulverisation, seems to prove such an exposure necessary, as also the frequent turning (or incessantly agitating) that fine dust for a year, before the barren exhausted earth was made rich and prolific: for besides the benefit of pulverisation and impregnation, land is more enriched in proportion to the time of exposure, during which it is free from exhaustion, and continually receiving from the atmosphere; therefore frequent turning and exposure are both contained in the words *pulverise* and *not exhaust*; and to comply with the latter, we should endeavour that our land may be never exhausted by any other

plants than by those we would propagate, and by no more of them neither, than what are necessary for producing a reasonable crop ; which upon full trial will be found a very small number in comparison to those that are commonly sown ; and then if the supply from the atmosphere by help of the pulverisation exceeds the exhaustion, the land will become richer, though constant crops are produced of the same species, as in the vineyards ; and the soil of these are so much improved by a bare competent exhaustion and the usual pulverisation, that after producing good annual crops without dung, until age has killed the vines, they leave the soil better than they found it, and better than contiguous land of the same sort kept in arable-field culture.

By pulverisation are meant all the benefits of it that accrue to the pasture of plants ; and by exhaustion, all the injuries that can be done to that pasture, except burning. And as the benefits of pulverisation visibly continue for several years, so do the injuries of exhaustion ; which appear by the ends of some of my rows that have been cleansed of weeds in their partitions by the hand-hoe, and the other ends of the same rows not cleansed ; the difference is visible in the colour of the wheat in the third and fourth following crops, equally managed ; and this is no more to be wondered at, than that two unequal sums, being equally increased or diminished, should remain unequal, until an addition to the lesser, or a subtraction from the greater, be made ; which, in case of the soil, must be either by a greater pulverisation or a lesser exhaustion.

Equivocus, in the last-mentioned page 125, relates that an exposure of the earth to the sun all the summer would rather enervate and impoverish, than enrich an extraordinarily fine loamy land, or mouldy ground ; but as it appears throughout his whole treatise, that he is most fond of false positions wherever he finds them, and when he does not

find them, he forges them out of his own brain, he must excuse me for suspecting this position to be of the latter sort, unless he can produce some other author for it. I am sure it is contrary to all the experience I ever saw in any sort of land, or heard of before on this sort of land.

Their one year's tillage, which is but two ploughings before seed-time, commonly makes but little dust, and that which it does make, has but a short time to lie exposed for impregnation; and after the wheat is sown, the land lies unmoved for near twelve months, all the while gradually losing its pasture, by subsiding, and by being continually exhausted in feeding a triple stock of wheat-plants, and a stock of weeds, which are sometimes a greater stock. This puts the Virgilians upon a necessity of using dung, which is, at best, but a succedaneum of the hoe; for it depends chiefly on the weather, and other accidents, whether it may prove sufficient by fermentation to pulverise in the spring, or not: and it is a question whether it will equal two additional * hoeings, or but one; though, as I have computed it, one dunging costs the price of one hundred hoeings.

It is possible, perhaps, to pulverise the ground with a pen, and they seem to act almost as oddly, when, at such a vast expense, instead of a hoe, they make use of a t—, to help them in their pulverisation.

When they have done all they can, the pasture they raise is generally too little for the stock that is to be maintained upon it, and much the greatest part of the wheat-plants are starved; for from twenty gallons of seed they sow on an acre, they receive commonly no more than twenty bushels of wheat in their crop, which is but an increase of eight grains for one. Now, considering how many grains

* Additional, because there must first be several hoeings to make our triple row equal to an undunged six-feet ridge of sown wheat.

there are in one good ear, and how many ears on one plant, we find, that there is not one plant in ten that lives till harvest, even when there has not been frost in the winter sufficient to kill any of them; or, if we count the number of plants that come up on a certain measure of ground, and count them again in the spring, and likewise at harvest, we shall be satisfied, that most, or all of the plants that are missing, could die by no other accident than want of nourishment.

And they have oftener less than sixteen bushels; and this harvest, 1735, a substantial experienced farmer had no more than four bushels of wheat to an acre throughout a field of forty acres, being robbed by poppies; and I have known a crop that has amounted to no more than two bushels to an acre, and some crops less, though dunged and fallowed; so that, taking the common sown crops of wheat one with another, they are thought not to amount to sixteen bushels to an acre, *communibus annis*.

They are obliged to sow this great quantity of seed, to the end that the wheat, by the great number of plants, may be the better able to contend with the weeds; and yet, too often at harvest, we see a great crop of weeds, and very little wheat among them. Therefore, this pasture being insufficient to maintain the present crop, without starving the greatest part of its plants, is likely to be less able to maintain a subsequent crop, than that pasture which is not so much exhausted.

When their crop of wheat is much less than ours, their vacancies (if computed altogether) may be greater than those of our partitions and intervals; theirs, by being irregular, serve chiefly for the protection of weeds; for they cannot be ploughed out, without destroying the corn, any more than cannons firing at a breach, whereon both sides are contending, can kill enemies, and not friends.

Their plants stand on the ground in a confused manner, like a rabble; ours like a disciplined army: we make the most of our ground; for we can, if we please, cleanse the partitions with a hand-hoe*; and for the rest, if the soil be deep enough to be drilled on the level†, in triple rows, the partitions at six inches‡, the intervals five feet; five parts in six of the whole field may be pulverised every year, and at proper times all round the year.

The partitions being one-sixth part for the crop to stand on, and to be nourished in the winter, one-sixth part being well pulverised, may be sufficient to nourish it from thence till harvest; the remainder, being two-thirds of the whole, may be kept unexhausted, the one-third for one year, and the other third of it two years; all kept open for the reception of the benefits descending from above, during so long a time; whilst the sowed land is shut against them, every summer, except the little time in which it is fallowed, once in three years, and a little, perhaps, whilst they plough it for barley in the winter, which is a season seldom proper for pulverising the ground. This may be done, though the roots of a competent number of plants run through the whole, in the manner hereinbefore explained.

Their land must have been exhausted as well by those supernumerary plants of wheat, while they lived, as by those that remain for the crop, and by the weeds. Our land must be much less exhausted, when it has never above one-third

* Of all annual weeds.

† This is only put as a supposition; for I have for these several years left off drilling on the level, and do advise against it; because, although mould should not be wanting for the partitions in deep rich land, yet it is much more difficult to hoe on the level than on ridges.

‡ But when it is drilled upon ridges, the proportion is less by how much the partitions, being thicker in mould, contain more than a sixth part of the whole six feet of earth, and the proportion of unexhausted earth will be altered likewise; and I only mention these distances to avoid fractions.

part of the wheat-plants to nourish that they have, and generally no weeds; so that our hoed land having much more vegetable pasture made, and continually renewed, to so much a less stock of plants*, must needs be left, by every crop, in a much better condition than theirs is left in by any one of their sown crops, although our crops of corn at harvest be better than theirs†.

They object against us, saying, that sometimes the hoeing makes wheat too strong and gross, whereby it becomes the more liable to the blacks (or blight of insects); but this is the fault of the hoer, for he may choose whether he will make it too strong, because he may apply his hoeings at

* Therefore, whenever a soil receives more supplies of fine earth from the atmosphere, than is exhausted by all the plants that grow in the soil, it becomes richer; but if the contrary, then it becomes poorer.

† On an undunged low six-feet ridge, we have three rows, eight inches asunder, all which being equal, during the winter, but each of the two outside rows at harvest producing ten times as much wheat as the middle row doth, all three together produce a quantity equal to one-and-twenty of this middle row. Now, supposing the roots of this row not to reach through the outside rows, so as to receive any benefit from the hoed intervals, then this row might only be equal to one of nine rows, which should have been drilled eight inches asunder on this ridge, and then our three would only be equal to twenty-one of such nine rows. But since it can be demonstrated, that the roots of our middle row do pass through both the outside rows far into the hoed intervals, we may well suppose it to be at least double to what it would have been if it had had no benefit from the hoeing, and then our three will be equal to forty-two of such nine unhoed rows. Thus our crop is thirty-three in forty-two (or almost four part in five) increased by the hoeing; for though many fields of wheat have been drilled all over in rows eight inches asunder, it never has been judged in twenty years' experience, that a crop so planted, though not hoed, was, by its evenness and regularity, less, *ceteris paribus*, than a crop sown at random.

I have left off making low ridges, unless when my ploughmen make them so against my will; but when land is drilled on the level, they are always low, though they do become ridges by the furrows that are sunk on each side of them by the hoe-plough: but these never produce the middle row equal to the other two; though in such the earth raised up higher in the middle of each interval in the winter is a shelter to the rows.

proper times only, and apportion the nourishment to the number and bulk of his plants. However, by this objection they allow, that the hoe can give nourishment enough, and therefore they cannot maintain that there is a necessity of dung* in the hoeing husbandry; and that, if our crops

* As for the quantity of vegetable matter of dung, when reduced to earth by putrefaction, it is very inconsiderable, and, of many sorts of manure, next to nothing.

The almost only use of all manure, is the same as of tillage, viz., the pulverisation it makes by fermentation, as tillage doth by attrition or contusion; and with these differences, that dung, which is the most common manure, is apt to increase weeds, as tillage (of which hoeing is chief) destroys them, and manure is scanty in most places, but tillage may be had everywhere. Another difference is, the vast disproportion of the price of manure and that of tillage.

Note, as we have no way to enrich the soil, but by pulverisation of manure or of instruments, or of both; so Nature has ordained, that the soil shall be exhausted by nothing, but by the roots of plants.

Equivocus says this opinion of Dr. Woodward concerning manure hath been often confuted; but does not say how or by whom: and until that be known I shall conclude the Doctor's opinion herein unanswerable, being built upon a sure foundation. The matter of fact is true, that the salts of dung will kill plants, when *insumed* by them; and when the operations made by those salts upon the body and juices of a plant are seen to kill it, it is not improper to say they poison it. It is not enough for Equivocus to assert, that it is not the quality but the quantity of them that have this deleterious effect; for he may assert the same distinction in favour of almost any poison; a small quantity of which may be taken without causing death. But a small quantity of salt killed the mints in my experiments, where only one string of a root that had many was put into the salt.

But the greatest quantity of earth that a plant ever insumes doth not kill but nourish it. Could it be shown that those salts, mixed with moist earth, did not pulverise it, it would be a strong argument against my above definition of its use; but as it is seen always to pulverise the earth, and to kill plants when taken in any considerable quantity, and not to nourish them, why should not the same degree of pulverisation made by tillage, and the same exposure with no greater exhaustion, keep the ground from going weary or tired, as well as if part of that pulverisation were made by the ferment of those salts? That practice tells the contrary, I deny; because I have seen what I have advanced proved by long practice. I have never affirmed that part of the necessary degree of pulverisation made by tillage alone, without the salts of manure, will have the same effect as the whole

of wheat should happen to suffer, by being too strong, our loss will be less than theirs, when that is too strong, since it will cost them nine times our expense to make it so.

necessary degree of pulverisation made by tillage, and those salts together will ; neither have I said that tillage alone can pulverise to that degree in all sorts of land ; for there are some sands that have very little earth in the staple of them, and that little may require a greater degree of pulverisation than can be obtained from the plough alone, in a reasonable time of exposure. Pure sand consists of very small stones that are perfectly barren, when no earth is amongst them, as the sands of Libya are : but when sand is full of good mould, it is, by its richness and friability, the most profitable soil that is ; and the most likely to be sufficiently pulverised by tillage alone.

Of what sort the sands of Essex and Kent are, I know not, nor perhaps Equivocus neither ; yet he presumes to pronounce that should I affirm of those sands the same thing that I (and some modern authors) have advanced concerning other lands, as above, “ the Essex and Kentish men “ would think me (and that with great justice too) a madman.” But whether they will not (with greater justice) think Equivocus a madman for recommending the manure he extols in his Preface to June, I leave to the judgment of every impartial reader. It is as follows, viz., he extracts it from one who, in his opinion, is an exceeding good author, asserting that land may be “ manured with malt cheaper (sometimes) than with “ dung, nor does it matter what corn the malt is made of ; for by this “ means it is converted into the substance of the wheat, together with the “ benefit of the multiplication : neither is it material whether the malt be “ ground or not, especially for any corn sown before winter ; because that “ is the time the whole grain will be dissolved and putrefied, so as that by “ little and little it may be assimilated to the nature of the grain you would “ improve, by sweetening (as we add) the sour and unhealthy juices of “ that land, and by giving it a new sweet ferment (the original of all “ vegetable motion) it will produce admirable effects on that corn on (or “ with which) it is sown.”

Here, patient reader, you have the theory and practice both of the (falsely entitled) Practical Husbandman and his exceeding good author.

It is such a specimen of profound knowledge in practical agriculture, and skill in choosing the best speculative authors, that I have not patience to animadvert upon it ; but it leaves no doubt, whether the Private Society have made good their unparalleled bragging promise, that theirs should “ be such a system as never appeared in the world before.”

Before I conclude my notes on this Chapter of the comparison between the two sorts of husbandry, I will give an answer to a very false and malicious assertion of the Equivocal Society ; though having already proved their notorious and wilful want of veracity in their pretended description

A second objection is, that as hoeing makes poor land become rich enough to bear good crops of wheat for several

of my farm, and in many other particulars, I need take no notice of any more of their untruths (with which their work so plentifully abounds), but this one on which they lay the greatest stress. It is, in p.37 of their Essay for July, in these words, viz., "The proprietor himself, instead of raising "one estate by this and other new-invented pieces of husbandry, has well-nigh spent two."

These latent authors must be very much conceited of their own penetration, if they pretend to know my affairs better than I do: and if I know them, I have been so far from spending an estate in any manner, that my circumstances are now better than when I first set out in the world, notwithstanding many uncommon and inevitable misfortunes of divers kinds that have befallen me; amongst which, the loss of health, obliging me to quit the profession to which I was bred, and to travel for saving my life, may be reckoned.

As to agriculture, it was not by choice, but a sort of necessity, that I practised it; and I never kept an acre in my hands, that I could reasonably dispose of to a tenant; I knew too much of the inconveniency and slavery attending the exorbitant power of husbandry servants and labourers over their masters, to propose to myself any other gain by occupying of land, but to repair the injuries done it by bad tenants, and to keep it, till I could let it at a reasonable rent to such as I thought good ones.

I have occupied only two farms, the first was in Oxfordshire. I so much improved that farm in nine years, as to let it for above a third more rent than it was ever let for before; and that being almost thirty years ago, the rent is not sunk yet, but likely always to continue or increase. But the lands of the farm I have now, lie so remote from all farmers, that they cannot be let without the house where I live, and which is situate in an air that I would not willingly part with. To avoid this, and yet to be out of trouble, as I was likely to be confined to my bed, I prepared materials for building a new farm-house, and had in a manner agreed with a tenant to enter on my farm the last summer, which was disappointed by an accident, and now perhaps I may be forced to keep it as long as I live. However that may happen, I am confident (all things considered) that in the time I have already occupied it, if I had managed it in the common husbandry, the value of its purchase would have been lost by it; though a robust able-bodied farmer in the clovering and turnip method might have thrived upon it: but every Virgilian farmer that has rented it (and here have been few other, since it was first made into a farm), that being about seventy years ago, has either broke, or quitted it before the end of his term.

It is to the new husbandry that I owe the property of my farm, and all that I here have said I can make appear to any gentleman whose curiosity shall induce him to inquire of me to find the truth for his satisfaction. My estate is not so large as to leave an overplus for acquiring another, after

years successively, the same must needs make very good land become too rich for wheat. I answer, that if possibly it should so happen, there are two remedies to be used in such a case; the one is to plant it with beans, or some other vegetables, which cannot be overnourished, as turnips, carrots, cabbages, and such like, which are excellent food for fattening of cattle; or else they may make use of the other infallible remedy, when that rich land, by producing crops every year in the hoeing husbandry, is grown too vigorous and resty, they may soon take down its mettle, by sowing it a few years in their old husbandry, which will fill it again with a new stock of weeds, that will suck it out of heart, and exhaust more of its vigour, than the dung*, that helps to produce them, can restore.

There is a third objection, and that is, that the benefit of some ground is lost where the hoe-plough turns at each end

the expenses of maintaining me in the manner I have been accustomed to live. I propose no more than to keep out of debt, and leave my estate behind me better than I found it; which, unless some new accident prevent, I shall perform: whilst not only many farmers in my neighbourhood have broke, and several gentlemen-farmers have lost their estates larger than mine, and others more money than all I have is worth, by the old husbandry, and by the many chargeable superinductions, their horses, bailiffs, &c., incident thereto, within the time I have been practising my scheme, though generally the first inventor of a project is a loser. But my scheme diminishes the usual expense so much, that one who understands it can scarce be in danger of losing by it: yet, owned it must be, that had I, when I first began to make trials, known as much of it as I do now, or as the diligent reader of my Essay and this Appendix may, the practice of it would have been more profitable to me.

But suppose I had worsted my substance, are there not many who by family misfortunes or otherwise have lessened their estates, though they have never practised agriculture? Nor do I think any gentleman ought to repine at the smallness of his estate, if (without his own fault) it be reduced to his bare share of the island; which will be in justice the less in proportion as that possessed by his ancestors has been greater and longer enjoyed.

* Dung made of the straw of sown corn, generally abounds with the seed of weeds.

of the lands; but this cannot be much, if any, damage; because about four square perches to a statute acre is sufficient for this purpose, and that, at the rate of ten shillings rent, comes to but threepence, though this varies, according as the piece is longer or shorter: and supposing the most to be eight perches, that is but sixpence per acre; and that is not lost neither, for whether it be of natural or artificial grass, the hoe-plough in turning on it, will scratch it, and leave some earth on it, which will enrich it so much, that it may be worth its rent for baiting of horses or oxen upon it. And besides, these ends are commonly near quick-hedges or trees, which do so exhaust it, that when no cattle come there to manure it, it is not worth the labour of ploughing it.

ADDENDA TO HORSE-HOEING.

The reason for publishing these Addenda is to give some account of a crop of 100 acres of White Cone Wheat, drilled in double rows, the partitions, some a foot, some ten inches wide ; and of many other things which I think may be acceptable and useful to the Reader.

I WAS desired to take an exact account of the product of a single land of hand-hoed wheat, and of an acre in the middle of a field of twenty-five acres of horse-hoed wheat, in order to know the different quantities produced by them.

The first was in a common field, and planted upon the level, with the same drill that planted the other, whereby there was a space of ten inches between two rows, and a space of eighteen inches between those and the next row ; so that each row had fourteen inches of surface for the roots to spread in ; it was hand-hoed very well ; the land had not been dunged in any manner since the year 1719. This crop was reaped very low, and thrashed out immediately ; it produced eleven bushels and a half ; the measure of the land being fifty-two perches, the product is at the rate of thirty-six bushels and six gallons to an acre ; it is situate next to the ditch of a meadow, and is all the land I have in the common field. The lands adjoining to it, of the same goodness, were judged, by all gentlemen and farmers who viewed them, not to have above half the wheat on them that this had, perch for perch ; and yet there was no difference in the management, except this being regularly planted and hand-hoed

without dung, and the other sown at random, and dunged (as they always are once in three years); the fallowings and ploughings of both were the same. Mine was said by several of the farmers of the place to be the best land of wheat in the parish.

This indeed ought to be allowed, that mine being mostly white-cone wheat, and the adjoining lands of clean Lammas, might make some part of the difference; but there being some of the same sort of Lammas amongst this cone, it was observed to be as high as the cone, and the ears of it to be of double the bigness of those in the contiguous sown lands.

As to the acre of horse-hoed wheat, it was measured eight perches broad and twenty long; which is equal to sixty-six feet in breadth, and six hundred and sixty in length, this being the statute measure of an acre; and we use no other for land in this country.

This acre being laid by itself, was after some time thrashed, and yielded twenty-nine bushels and six gallons of clean wheat.

Before it was thrashed it was somewhat diminished by cows that found a hole betwixt the boards of the barn, and pulled out some of it, and poultry eat more of it; but the most extraordinary waste was made by bad reapers, to whose lot this acre fell: they cut it so high that many of the ears which by their great weight bended down very low, were cut off and fell on the ground, and were there left much thicker than is usual. This waste was greater than any I had ever seen; so that, I believe, if it had been as well reaped as most of the rest of my wheat was, there would have been thirty-two bushels received from this acre.

The difference of the appearance of the hand-hoed and of the horse-hoed, whilst they were standing, was so great as to deceive many who saw them, and to induce some to

imagine that the product of the former would be double to that of the latter ; though it was really very little more than an eighth part greater.

The horse-hoed shows the whole interval empty until the grain is almost full, which is a great advantage to the crop ; because unless the air did freely enter therein to strengthen the lower parts of the stalks, they would not be able to support such prodigious ears (some containing 112 large grains a-piece) from falling on the ground.

When the grains are full, the ears turn their upper ends downwards, and are all seen in the intervals, and nothing but straw on the rows ; this reverse posture of the ears defends them from the injuries of wet weather when ripe ; for the rain is carried off by their beard and chaff, which, like tiles, protect the grain from being discoloured, as sown wheat always is by much rain, when ripe.

This difference was fully shown the last harvest, when all my wheat was in the same posture ; none of the ears reached the ground, but some reached within a foot, others within half a yard of it, and some not so low ; none of the straws were broken by the weight of those large ears, they only bended round at the height of about a yard or higher, in a manner that I never saw in any other wheat but the horse-hoed.

In these intervals, notwithstanding this bending posture of the ears, one may walk backwards and forwards without doing any damage ; for the ears when thrust out of their places, will, by their spring, return to them again like twigs in a coppice.

If a field of such wheat for want of a good change of seed, or by any other cause, should be smutty, the smutty ears will stand upright over the rows, and may, at the expense of about a shilling an acre, be cut off with scissors by women and children, which is the only perfect cure for

that malady when it happens; and the damage of it is nothing but this small expense, and the loss of the ears cut off, which, though they should be but the fortieth part of the crop (as they are seldom more), would spoil it; but, being thus taken out, leave the remainder generally large bodied, and as fine as that which hath no smut amongst it, except that it is not fit for seed. There is not this convenience either in sown or hand-hoed wheat.

As to the different profit of the hand-hoed and the horse-hoed crops, it will upon examination appear to be contrary to the opinion of the vulgar. The soil of the hand-hoed being at least as good as of the other, let us suppose them equal, and also the expense to be equal (though generally that of the horse-hoed is the least).

The hand-hoed was planted on a fallow, but the other had a good crop of wheat the preceding year drilled in double rows; and the year before that, had a crop of barley drilled in triple rows; the ridges always of the same breadth. All these crops were horse-hoed; but in the year before the first of these, the field had a crop of sown black oats; so that there were four successive crops without any fallow or dung. And there is now growing a fifth crop, being wheat, likely to be much greater than any of the precedent, if the year prove as favourable; therefore here being two crops of wheat for one, the profit of the horse-hoed is almost double to that of the hand-hoed.

And as the hand-hoed has but one wheat crop in three years, and one barley crop, which is commonly scarce half the value of a wheat crop, and the expense of the three years being in seed, tillage, &c., as much as of the three wheat crops, the profit of the horse-hoed will be more than double to that of the hand-hoed.

And this I think is a strong proof of the efficacy of deep hoeing, which, without a fallow, can (as in this case) cause

one double row to produce as much wheat as two double rows of the shallow-hoed did with a fallow in an equal quantity of ground ; which could not be unless each row of the lesser number did produce more or larger ears, or both, than each row of the greater number ; neither could this be, if the roots did not take the greatest part of their nourishment from the pulverised intervals, considering that the rows that had no fallow must, without the deep pulverisation, have produced much fewer and lesser ears than an equal number of rows that had the benefit of a fallow.

Vain, therefore, is the opinion of those who say the roots of wheat do not reach further than two or three inches from the stalks ; for if they did not, these horse-hoed rows could have very little or no nourishment from the pulverisation of the intervals not entering into them ; and then must have produced less than an equal number of rows of the hand-hoed (that had a fallow) did, instead of almost twice as much.

The other fields of my hundred acres of wheat, though the produce of all of them was not ratably so great as of the above-mentioned ; yet they brought crops much better than could be expected from the circumstances in which they were planted, viz., two fields whose staple is a cold sand lying upon a chalk (which is naturally a poorish soil) after a sown crop of barley, had two successive crops of horse-hoed black oats, both of which were of a great bulk in straw, though the grain (I know not whether by too late planting or the unkindness of the years) was not so good as the bulk of straw was great.

They were drilled in triple rows upon ridges of fourteen to an acre ; but from the breadth of the partitions, and height of the ridges, there was very little earth left to be pulverised in the intervals. After this vast exhaustion, and little pulverisation, the crop of wheat was drilled in double rows with ten-inch partitions, and the ridges of the same breadth as

before for the oats. This was the fourth crop without a fallow to any of them; but there was part of one of these fields dunged for the first crop of oats.

I was persuaded, against my inclination, to suffer these two fields in such bad circumstances to be planted with wheat; and when I got abroad in the spring to see it, I was in the mind to plough it up; but considering the time requisite for doing it would hinder the hoeing of some of the other fields, it was suffered to stand, and was afterwards hoed, &c., as the other fields were; but being planted late, could not be hoed till after the time of frutication (*i. e.*, tillering) was past, and then it was too late to increase the number of stalks by the pulverisation, though time enough to increase the bigness of the ears, as in truth it did; for they were near as large as any, and hung down into the intervals in the same reversed posture of the rest of my crop; yet for the fewness of the ears, I judged these two fields to have but half the crop of the best fields; and the parson having thrashed out his tithe, I am informed, it shows this half crop to be sixteen bushels to an acre.

The present crop is likely to succeed much better; because the precedent having single partitions, and lower ridges than the oats had, there was much more pulverised earth in the intervals; for this present growing crop will thereby have the benefit of frutication, in the first place, and of the repulverisation of that earth afterwards.

There were six acres on the brow of a chalky hill made so poor by several sown crops of barley, and after them a very poor crop of black oats and weeds, that I ordered the piece to lie fallow; but when I got abroad, I found it to my surprise planted with wheat, without my knowledge, and was over and above the 100 acres. It was a little horse-hoed, too, in the oats, though it was not cleansed of the weeds; but the crop of wheat had the weeds cleansed out by hand-

work, and the intervals pulverised by the horse-hoe, and was a better crop than that of the two fore-mentioned fields. The piece is now in wheat again, and is vigorous and strong, making a very fine flourishing appearance.

Next to this is a field of nineteen acres, reaching from the top to the bottom of the same chalky hill; it was fallowed, and all my dung laid upon the upper part of it. This field brought a crop, judged to be, by all who saw it, more than a third bigger than that of the last-mentioned piece.

The wheat on the bottom of this hill where no dung was laid, was (I suppose, by the different goodness of the land) as strong, and as good, as the part that was dunged, except an acre or two that was eaten by worms, a sort of millipedes, yellowish and horned, generally not an inch long; they eat off the stalks from the root, and are sometimes found twenty in one plant of wheat; they are said to be bred in dry mossy land. This worm-eaten part is a vein of the whitest land that I ever saw, it was four or five years ago in St.-Foin and a bed of moss; before the fallow it had a crop of sown black oats, which was eaten by the worms in the same place where the wheat was eaten. I hoped the fallow would have killed them; but it is said they generally live three or four years after the moss is ploughed up. I see no sign of them as yet in the present crop, and they did the damage long before this time the last year.

I must not forget to observe that the last sown crop of wheat upon this field was destroyed by poppies, and these winter and summer ploughings had so well pulverised the soil that the seeds almost all grew, and would infallibly have destroyed this whole crop (as the worms did an acre or two of it) had not these young poppies been timely clean taken out, which had been next to impossible in a random crop. They were almost as thick as if their seed had been there spread

with a shovel ; therefore it is certain this crop of wheat was owing to the regular planting and hoeing.

It is probable the Virgilians, on account of such weeds, are afraid to plough such land above once for wheat, because, when poppies or the like do grow in their wheat, they cannot take them out timely enough to save their random crop from destruction.

Another wheat-field of seventeen acres was planted in December after two successive crops of oats. I have found, indeed, that the white-cone wheat endures late planting better than any other sort that I know ; but this field lying far from any house and near to the rookeries, I was apprehensive that the rooks would devour my wheat at coming up, there being no other wheat thereabouts but what was then up and out of danger ; but my overseer taking upon himself the care of defending it, and engaging to be answerable for the rooks, I consented it should then be planted ; yet, contrary to his engagement, he went away upon pleasure and diversion, taking no care of the wheat at the critical time ; whereof the rooks took the advantage, and devoured a great part of it : whether they did eat the fourth or half I know not, because the crop is stacked up in a rick alone by itself, not to be thrashed till next summer. But by what the rooks left, it appeared that it would have been one of the best crops I had if they had been kept from it.

This I am confident of, that I have more wheat yearly, than the tenant had on the same farm in four or five years.

The field which had last year the eleventh crop of wheat, has now the twelfth on it, very likely to be a good one.

Perhaps it may be asked, Why I drilled so many oats when a crop of wheat is much more valuable than a crop of oats, and the expense of both is nearly equal ? I say it was by the disappointment I had of a tenant, who I expected would

have sown the wheat crop, so that I did not prepare to plant it; and then I was forced to plant spring corn, or else let it lie for a fallow: but the following autumn I planted all such land with wheat that I thought was in tolerable condition for it; and the next autumn after that I drilled the hundred acres; and now I have, in good condition, six score acres of wheat, a hundred acres of which are on the stubble of the last year's wheat-crop.

It is true, I was at great loss by giving attention to that tenant; but I was desirous of being out of all business, my infirmities increasing upon me, and having no one of my family whom I thought capable and proper to leave in it after me, it was the best way to let my farm, if I could have met with a good tenant.

Of Dung.—I keep a team of horses for the use of a tile-kiln, which helps me at present to dung for about ten acres yearly; but if I put them off, as I intend, I shall not raise dung for above three acres; yet I propose to have six score acres of wheat every year, as I have at this time; a hundred of them being drilled on the stubble of my last year's wheat-crop; but if I had only dung for three acres, I could then have no more than three acres of wheat in a year, by the old husbandry. Well it is for me, that dung is not necessary in the new husbandry.

Roots insume their Pabulum by Pressure.—Roots cannot have any nourishment from cavities of the earth that are too large to press against them, except what water, when it is in great quantity, brings to them, which is imbibed by the gentle pressure of the water; but when the water is gone, those large cavities being empty, the pressure ceases; and this is the reason that when land has few other but such large cavities, the plants in it always suffer more by dry weather, than in land which, by dung or tillage, has more minute and fewer larger cavities.

There may be some moisture on the superficies of larger cavities ; but, without pressure, the fibrous roots cannot reach it ; and very little or no pressure can be made to one part of the root's superficies unless the whole that is included be pressed.

If it be objected that a charlock-plant, when pulled up and thrown upon the ground, will grow thereon, this proves nothing against the necessity of pressure, &c., for the weight of that plant presses some of its roots so closely against the ground, that they send out (unless the weather be very dry) new fibres into the earth, and there they are pressed in all their superficies, without which fibres the plant doth not grow.

Of the Destruction of Weeds.—I have now a piece of wheat, drilled early the last autumn upon a hill, fallowed and well pulverised ; part of it was drilled with wheat in double rows upon the level nine years ago, horse-hoed, and the partitions thoroughly hand-hoed to cleanse out the poppies, of which the land was very full ; the other part of this piece was never drilled till this year ; the whole piece hath not been before this winter horse-hoed ; now the partitions of the part that was never any way hoed, are so stocked with poppies matted together, that unless they are taken out early in the spring they will totally devour the rows of wheat ; but in the other part that was hoed so long since, there are now very few poppies to be seen. Both these parts have had several sown crops of barley together since, and have lain with St.-Foin these last five or six years.

The Cause of a Wheat-Crop following a drilled Crop being better than after a dunged Crop.—If the dung did pulverise as much as the hoeing, the cause must be from the different exhaustion.

Of preventing Damage by Rooks.—It is true, that wheat which is planted early enough for its grain to be unfit for the

rooks, before the corn that is left on the ground at harvest is either all eaten by them or by swine, or else growed, ploughed in, or otherwise spoiled, is in no danger; but as this sometimes happens soon after harvest, the time of which is uncertain, a timely care is necessary.

Many are the contrivances to frighten the rooks; viz., to dig a hole in the ground, and stick feathers therein; to tear a rook to pieces and lay them on divers parts of the field; this is sometimes effectual; but kites or other vermin soon carry away those pieces. Hanging up of dead rooks is of little use; for the living will dig up the wheat under the dead ones. A gun is also of great use for the purpose; but unless the field in time of danger be constantly attended, the rooks will, at one time or other of the day do their work, and you may attend often, and yet to no purpose, for they will do great damage in your absence.

The only remedy that I have found infallible, is a keeper (a boy may serve very well) to attend from morning until night; when he sees rooks either flying over the field, or alighted in it, he halloos, and throws up his hat, or a dead rook into the air, upon which they immediately go off, and it is seldom that any one will alight there, they finding there is no rest for them, they seek other places for their prey, wherein they can feed more undisturbed.

This was the expedient I made use of for preserving my present crop: it succeeded so well, that in six score acres, I believe there is not twopence damage done by the rooks: but I had two boys (one at fourpence and the other at threepence a day) to attend them; because my wheat is on two sides of my farm; the whole expense was about twenty shillings. The damage I received by rooks the last year in a field of seventeen acres was more than would have, in this manner, preserved my whole crops for twenty years running. I wish

I could as easily defend my wheat against sheep, which are to me a more pernicious vermin than the rooks.

Of the Middle Row.—I have now entirely left out the middle row for wheat, for the following reasons :

It makes the cleansing from weeds more difficult, than when there is only a double row.

The hand-hoe cannot give near so much nourishment (*i. e.*, pulverise so much earth) in two seven-inch partitions, as it can in one ten-inch partition.

There are four inches less earth to be pulverised by the horse-hoe from the surface of a ridge that has two seven-inch partitions, than from a ridge that hath one ten-inch partition.

The ridge must be almost twice as deep in mould for the triple as for the double row, or else the middle row will be very weak and poor, and then, according to the principles, the whole ridge will be more exhausted than by an equal produced by strong plants.

As the ridges may be much lower that have only one partition, so the intervals may be narrower, and yet have as much earth in them to be pulverised, as in wide ones that are betwixt triple rows, because the four inches that are in the two partitions more than in the single partition, being on the top of a ridge, may have more mould under them than eight inches on the side of a ridge: and the four inches being in the partitions, lose the benefit of horse-hoeing.

Instead of using the middle row as an alloy, it is better to plant such sorts of wheat as do not require any alloy to the double row, and these are the white cone, and above all other sorts the right Smyrna.

The white-cone wheat must not be reaped so green as the Lammas wheat may; for if it is not full ripe, it will be difficult to thrash it clean out of the straw.

It happened once that my white cone being planted early, and being very high, the blade and stalk were killed in the winter, and yet it grew high again in the spring, and had then the same fortune a second time; it lay on the ridges like straw, but sprung out anew from the root, and made a very good crop at harvest; therefore if the like accident should happen, the owner need not be frightened at it.

I have at this time for a trial five or six acres of right red straw wheat, that comes into this country as a rarity; but I cannot tell how it may succeed till harvest comes.

One thing that made six-foot ridges seem at first necessary, was the great breadth of the two partitions (which were eight inches a-piece), which, together with the earth left on each side of the triple row not well cleansed by hand-work, made two large whole furrows, at the first ploughing for the next crop, that could not be broken by harrows; these two strong furrows being turned to the two furrows that are in the middle of a narrow interval, for making a new ridge, would cover almost all the pulverised earth, not leaving room betwixt the two whole furrows for the drill to go in. But now the single partition and the earth left by the hoe-plough on the outsides of the double row, making two narrow furrows, and the one partition being cleansed and deeper hand-hoed than those of the triple row were or could be, are easily broken by the harrows: for besides their narrowness, they have no roots to hold their mould together, except the wheat roots, which being small and dead, have not strength enough to hold it; and therefore that necessity of such broad ridges now ceases along with the triple row.

When the two narrow fragile furrows are harrowed and mixed with the pulverised earth of the intervals, the roots of the wheat will reach it, and it is no matter whether the crop be drilled after two ploughings, in which case the row

will stand on the very same place whereon the row stood the precedent year, or whether it be drilled after one or three ploughings; and then the rows will stand on the middle of the last year's intervals.

I cannot prescribe precisely the most proper width of all intervals, because they should be different in different circumstances. In deep rich land they may be a little narrower than in shallow land.

There must be (as has been said) a competent quantity of earth in them to be pulverised, and when the soil is rich, the less will suffice.

Never let the intervals be too wide to be horse-hoed at two furrows, without leaving any part unploughed in the middle of them when the furrows are turned towards the rows.

Some ploughmen can plough a wider furrow than others that do not understand the setting of the hoe-plough so well.

By making the plant of the hoe-plough shorter and the limbers more crooked, we can now hoe in narrower intervals than formerly, without doing any damage to the wheat.

I now choose to have fourteen ridges on an acre, and one only partition of ten inches on each side of them. This I find answers all the ends I propose. If the partitions are narrower, there is not sufficient room in them for the hand-hoe to do its work effectually; if wider, too much earth will lose the benefit of the horse-hoe.

The poorer the soil is, the more pulverisation will be necessary to it.

When a great season of wheat is drilled, it cannot be expected that much of it can be ploughed dry, though it is advantageous when there happens an opportunity for doing

it ; but, by long experience, I find that in most of my land it does very well when ploughed in a moderate temper of moisture.

It may not be amiss to harrow it once after it is drilled, which will in some measure disappoint the rooks, besides covering the wheat, if perchance any should miss being covered by the drill-harrow.

But these and all harrows that go on a ridge, both before and after it is drilled, should be fastened together ; for if they should go in the common manner, the ridges would be too sharp at top, and the partitions would lie higher than the rows, and some of their earth would be apt to fall on the rows when it is hand-hoed.

By means of this level harrowing there is left an open furrow in the middle of the interval, which much facilitates the first horse-hoeing.

But when, after a crop is taken off, the ridges are ploughed twice, as they may be where the partition hath been well hand-hoed, it is better to harrow the first-made ridges in the common manner ; because then some of the fine earth that is harrowed down will reach to the middle of the intervals whereon the ridges are to be made for drilling. Or if there should be time for ploughing thrice, the ridges of the first and second ploughings are to be harrowed in the common manner also.

The harrowing of the ridges must never be crosswise, unless when they are to be made level for cross-ploughing, in order to lay out the ridges of a breadth different to what they were of before.

When you perceive the ridges are too high, harrow them lower by the described manner of harrowing ; first with the heavy harrows for harrowing out the stubble, and then with light ones, which may be often, for making the earth on the ridges the finer for drilling, without throwing much of it down :

frequent harrowings in this manner not being injurious like too much harrowing on level ground, which is sometimes trodden as hard as the highway by the cattle that draw the harrows; for in harrowing these ridges the beast that draws the harrows always treads in the furrows where there is none or very little mould to tread on.

The price of hand-hoeing of these double rows is a penny or thirty perches in length of row, which amounts to between eighteen and nineteen pence for an acre.

I should say that in hand-hoeing the earth must never be urned towards the wheat, for if it were, it might crush it when young; neither could the partition be clean hoed.

The hand-hoes for hoeing the ten-inch partition have their edges seven inches long; they are about four inches deep from the handle; if they were deeper, they would be too weak; for they must be thin and well steeled. The labourers pay for them, and keep them in order for their own use.

These hoes must not cut out any part of the two rows, nor be drawn through them, as the four-inch hoes sometimes may through the triple rows.

If I am taxed with levity in changing my triple rows for double ones, it will not appear to be done of a sudden, for in my first directions I advised double rows where hand-hoeing was likely to be necessary. I also advised the trial of both sorts. And now upon fuller experience I find the double rows much preferable to the triple, especially for wheat.

When gentlemen saw the middle row on low ridges, so much inferior to the outside rows, they were convinced of the effect of deep hoeing; for they said, there was no other reason for this so invisible a difference, except the outside rows standing nearer to the pulverised intervals than the middle row did.

And when on high ridges the middle row was nearly or

quite as good as one of the outside rows, I was not convinced that they were not diminished by the middle row, as much as the produce of it amounted to ; and this I now find to be the case ; for four rows of oats without a middle row produced somewhat more than the same number that had a middle row ; two of which triple rows were taken on one side, and two on the other side of the double rows, purposely to make an unexceptionable trial. And it is, as far as I can judge, the same in wheat.

It is true, I began my horse-hoeing scheme first with double rows ; but then they were different to what they are now ; for the first had their partition uneven, being the parting space, whereby it was less proper for hand-hoeing, which I then seldom used, except for absolute necessity ; as to cleanse out poppies, and the like. The intervals also were too narrow for constant annual crops.

By all these three methods I have had very good crops ; but as this I now describe is the latest, and is (as it ought to be) the best, I publish it as such, without partiality to my own opinions ; for I think it less dishonourable to expose my errors, when I chance to detect them, than to conceal them. And as I aim at nothing but truth, I cannot with any satisfaction to myself suffer any thing of my own knowingly to escape that is in the least contrary to it.

I have a piece of five or six acres of land which I annually plant with boiling-peas, in the very same manner as wheat ; except that the second horse-hoeing (which is the last) throws the earth so far upon the peas as to make the two rows become one. These peas cannot be planted until after the 25th of March, else two horse-hoeings might not be sufficient. The same drill that plants wheat plants peas, only sometimes we change the spindle, for one that has its notches a little bigger.

I drill no more barley because it is not proper to be fol-

lowed by a crop of wheat without a fallow ; for some of the shattered barley will live over the winter and mix with the wheat in the rows, and can scarce possibly be thence timely taken out, its first stalk and blade being difficult to distinguish from the wheat, and this is a great damage to the sale in the market ; and for the same reason I plant no more oats.

Note, Where it is said that I had left off making low ridges, it is meant of six-foot ridges, on account of the triple rows, which, together with six-foot ridges, I have now left off for wheat.

A Barley Farm converted into a Wheat Farm.—My farm was termed a barley farm, not from the good crops of barley it produced, but because the land being almost all hilly was thought too light for wheat ; for in their old management it was often destroyed by poppies and other weeds, and seldom was there a tolerable crop of wheat.

In a dry summer the barley-crop failed for want of moisture, and of more pulverisation, and was not worth half the expense.

Land is seldom too dry for wheat ; and this dry soil in the hoeing culture brings very good crops of wheat, which is the reason I have now no barley, except what is sown on the level, as it always must be for planting St.-Foin and clover amongst it ; were it not for that purpose I should plant no barley at all.

That Wheat Ears do not lodge by reason of their weight.—This was proved by my whole crop the last harvest, and particularly by the measured acre, the ears of which, though prodigiously large and heavy, were none of them lodged, when those of sown wheat on the other side of the hedge were fallen down flat and lodged on the ground.

Use but three Bulls in a Hoe-plough.—I now use no oxen, properly so called ; but only bulls, bought in at the time when they are cheapest, and have them castrated. These are hardier

than oxen, though of a lesser size. Oxen being castrated whilst they are calves, grow much larger than bulls. We never put more than three of these (they are called bull-stags) to a hoe-plough.

All Individuals formed and had their Existence in the first of their respective Species.—That is to say ; the first of each species that was created, contained in it all the individuals that have already, or ever will proceed from it.

Those who are of a contrary opinion give no better reasons than they who hold equivocal generation : for, it is as unreasonable to suppose a power in an animal or vegetable body to produce animalcules or plantules from inorganic matter by secretions of the aliment, as they pretend.

The first rudiments of animals and plants being organical, can be the work of none but the infinite Creator, though they are augmented and produced by the secretions, &c., of the aliment.

But the opposers of this doctrine make no distinction between creation and production ; nor seem they to have any notion of infinite division, or infinite smallness ; if they had, they would not make the objections they do against the creation of all animals or plants, at once contained within one another.

Neither is the multitude of animalcules that are lost any objection ; for if the Creator had not known it necessary there should be an overplus of them, he would not have made them so numerous.

The Rotting of Roots a Manure to Land.—Some have objected against this opinion, and say the effect was rather to be imputed to the rows of St.-Foin shadowing the earth under them, or else from their keeping the earth under them free from couch-grass, of which the intervals were full : but I think it more probable that the couch-grass, having

very long horizontal roots, might draw nourishment from the earth, under the rows, and from the intervals equally.

And as to the shadow of the rows, though for the first and second years the St.-Foin plants were very large, yet being afterwards, for five or six years, until ploughed up, constantly fed by cattle, and being more sweet were eaten very low, whilst the couch-grass remained entire in the intervals, and shadowed them more than the earth of the rows was by the St.-Foin. Besides the rotten turnips, which were free from both these objections, had the same effect on the barley as the St.-Foin had on the oats.

Of Exhaustion.—It is by this that both ends of these rows in time become equal; for though ten plants that produce an ounce of wheat insume more pabulum than one plant that produces the same quantity, yet a plant that produces six or seven drachms insumes less than one that produces an ounce; for a plant which produces six drachms of wheat, cannot be a poor one, and therefore insumes no more pabulum than in proportion to its augment and product. Thus the soil of those ends, which by being doubly exhausted by weeds and wheat-plants was made poorer, gradually recovers an equality with the other ends, by being for several years less exhausted than the other ends are, by larger plants, whilst the number of plants and the pulverisation of each are equal.

To the reasons already given there is another to be added, why horse-hoed wheat exhausts the soil less than sown crops, where the product of wheat produced by each is equal; which reason is, that the former has much less straw than the latter; as appears by the different quantities of grain that a sheaf of each, of equal diameter, yields; one of the former yielding generally double to one of the latter; for a sheaf of the sown has not only more small under ears, but also its best ears bear a less proportion to their straw than the other; for a straw of

sown wheat six feet high, I have found to have an ear but of half the size of an ear of drilled wheat on a stalk five feet high, having measured both of them standing in the field, and rubbed out the grain of them. 'This difference I impute to the different supply of nourishment at the time when the ears are forming.

Thus the sown crop exhausts a soil much more by its greater quantity of straw.

And this is one reason why annual crops of sown wheat cannot succeed as crops of horse-hoed wheat do. There must be dung and fallow to repair the exhaustion of the sown; neither of which are necessary for crops of the horse-hoed.

Of Trials.—Gentlemen who can get the Smyrna wheat, I advise to make trials of it in single rows of between seventeen and eighteen to an acre; in this method, there being no partitions, the intervals will be of the same width as in the ridges of fourteen to an acre, that have partitions of ten inches. Thus almost all the earth of the ridges may be pulverised by the hoe-plough in the field, or by the spade in this trial; and very little hand-work will be necessary for cleansing out the weeds that come in the rows and on each side of them. The land will be the fitter for a succeeding crop of wheat with less harrowing. But this must be observed, that in regard to hard frosts in winter and very dry weather in summer, the alternate hoeing described in the chapter "Of Turnips" may be proper; lest the little earth that may be left for the row to stand on, when the furrows are turned from both sides of it, should not be sufficient to secure the roots from the injuries that may happen to them by being exposed either to frosts or drought on both sides of the row at the same time.

In the field, when the ridges are all of an equal breadth, the best way is to plant two of the single rows at once.

Two gallons of Smyrna wheat, I judge, will be sufficient for an acre, especially if planted early.

Planting one row on a ridge I think is the most advantageous method of all; but not being able to get any Smyrna wheat (though I have been often promised it), I have made no trial of it; and I do not believe the plants of any other sort of wheat are large enough for such single rows.

I am not quite a stranger to this wheat; for I have seen the product of it, both in the garden and in the field, about forty years ago.

I am now making trials in order to know how much a single row of white-cone wheat will exceed half a double one; for this purpose, I cause one row of the double, with the partition, to be dug out with a spade, in part of every field, two or three yards in a place; these I intend shall be hoed as the double rows are, and where the hoe-plough doth not reach, the spade shall supply its use.

I do not expect this single row will equal the double row; but I am in no doubt but that it will produce more grain than half a double row.

I cannot tell whether the sort of cone-wheat that sends out little branches on each side of the ear might not succeed tolerably well in single rows; for its ear is, when well nourished, larger than the ear of the white cone; though not near so large as that of the Smyrna.

Another experiment I propose to be made as a trial for the satisfaction of such sceptical gentlemen who may doubt the truth of what I have related concerning the wonderful effect of deep hoeing. In a field of very poor old decayed St.-Foin, let two or three perches be hedged in, in a square piece, and two, three, or more intervals of three or four feet wide each, be well pulverised by the spade; leaving between every two of them two or three feet of the St.-Foin un-

moved. Begin this work in summer, and repeat the hoeing pretty often, observing the rules I have laid down for hoeing the intervals of wheat. Let not the back of the spade be turned towards the unmoved St.-Foin, from which it throws the earth at the first time of hoeing; which is contrary to the first hoeing of wheat with a spade; because there would otherwise be danger of moving the wheat roots; but there is no danger of moving the St.-Foin roots, unless you wholly dig them out; therefore the best way for hoeing is to dig with the back of the spade towards one or the other end of the interval; this cuts off the fewest roots and covers the most of them, and may perhaps be sometimes best for wheat also. When the ear is turned towards the St.-Foin rows, the spade's face will be towards them of course.

Be sure to leave four or more feet untouched next to the hedge that bounds the piece, to the end that the increase of the hoed St.-Foin may the more plainly appear, by comparing its plants with those that are not hoed.

If the plants are very thick, make them thinner on one side of an interval, and on the other side let them remain thick. You will certainly find the thin plants most wonderfully increased in a year or two, and the thick ones in proportion; and also the natural grass, and all other vegetables that grow near to the intervals when they are well pulverised. I am confident mine, thus managed by ploughs, increased some to a hundred, some to a thousand times the size they were of before that pulverisation.

All the methods I have here and elsewhere described for the field, I advise to be tried in these few perches for experiments.

I think some of those ridges, where one end is to be managed differently from the other end, should be longer than six feet: else the roots of the wheat and weeds may so mix and draw nourishment from one another in the middle

of the ridge, that the difference of the managements may not so plainly be seen as when the ridge is longer.

The few perches of land, whereon any of the proposed experiments are to be made, should be bounded in with dead hedges, and should not be situate within three or four poles of a live hedge or tree.

The three instruments to be used in these unexpensive trials, are the spade to supply the use of the plough and hoe-plough, the hand-hoe, and a rake instead of harrows.

Answers to Objections.—I am very lately apprised of a particular objection which I will answer, although it be, except in the particularity of it, much the same with one already answered.

It was reported the last season at the Bath, that a certain deceased Lord, not far from thence, was a loser by my husbandry ; which the spreaders of that report seem to think may be fatal to the reputation of horse-hoeing. But if it can appear either that my scheme was not duly executed, or that there was, upon the whole, no loss by it ; or if that part wherein my scheme was duly executed did succeed, and that part which was done contrary to it did not succeed, this report must be groundless and false.

As for the errors there committed in the execution of the scheme, being more than I thought possible, the reader of Preface to my fore-mentioned specimen, may see some of them ; they were all committed in some part of his lordship's agriculture ; besides some other errors not therein specified.

And, after that Preface was published, I received a letter from thence, desiring my advice what to do with a field wherein a crop of wheat drilled in triple rows, being reaped, had the rows so full of poppies, that they, with the stubble, looked like cut hedges.

This field, as I was informed (for I was never there), was part of three or four hundred acres drilled the same year,

which could not be all well hoed for want of cattle, between twenty and thirty fine horses of too great a price for the plough, being dead, or spoiled by the contrivance of an old steward, enemy to the new husbandry.

The rows could not have made such an appearance, if the weeds and the middle row had been chopped out together, or if the weeds had been cleansed out the year before, instead of suffering them to ripen and shed their seed on the land, which, being then well prepared to receive it, produced this plentiful crop of weeds the following year.

If the part which had a contrary management should have succeeded no better than it may be supposed this did, there might have been grounds for the report; but if it be true, as I have been informed by some who were privy to the accounts, that twelve hundred pounds were made of a crop of drilled wheat, when a much less number of acres were planted on land of a small rent, it is not likely there should be any loss by it.

Was there ever any sort of husbandry heard of that the owner, by bad management, could not be a loser by it?

However, let the horse-hoeing husbandry be never so ill managed, the loss may be less than in the old husbandry equally ill managed with so vastly a greater expense as it generally is. And I have never yet heard of a drilled wheat-crop in the worst management, of so little value as I have often seen random crops of wheat to be.

Nor has any of the opposers produced one single instance where this scheme, tolerably well executed, according to the principles and directions I have written, has not had a reasonable success: I am sure, I have never known any such instance; and doubtless, if there had been any such, some of the opposers would have produced it, instead of their ridiculous cavilling and wretched arguments, which serve for no other purpose but to deceive themselves and others.

Can it be reasonably believed that a person of his lord-

ship's known good sense and judgment would have continued the practice of a scheme so many years and annually increased it, unless he had seen it succeed whenever it was well executed, or if upon the whole he had been a loser by it?

I believe my lord might be two or three thousand pounds out of pocket or more; but this money was mostly expended upon building walls, making new ways, enclosing common fields and commons, planting many miles of quick-hedges, building a new farm-house and all other edifices necessary thereto, and new barns, &c., to others. The least part of this sum was laid out upon the agriculture itself, which when the crops and stock were sold, I never heard from any person who knew the affair, that there was any loss by the husbandry, but the contrary.

And as to the rest, by the enclosure, by a great deal of poor land drilled with St.-Foin, by the building, &c. (if my information be true), the estate is so much improved that it is now let for almost a thousand pounds a-year more rent than it was let for before these improvements, which in all probability had not been accomplished without taking those lands into hand and managing them for some time in agriculture, which I suppose nobody believes would have been undertaken but on account of the scheme these Bath reporters calumniate; for the year before his lordship began it, there was, on the largest estate, only four acres of wheat, their whole product was so small as to be contained over the porch of a barn, and when thrashed yielded but twenty bushels of grain.

It would be the highest reflection upon the memory of a person of his lordship's honour and integrity, to imagine he would give an approving judgment (as he doth expressly by letter) on the scheme on which he had made observations for many years, if he had not been convinced by his own knowledge and experience that it was just.

The errors in the execution, many of which might be

committed whilst his lordship was in parliament or elsewhere absent, he is so indulgent to his servants, as that he seems, in the letter, to take them upon himself.

After reading this letter, sure no man of sense will give credit to the report of scoundrel servants, contrary to the purport of it; such commonly delight in propagating falsehoods to deceive the vulgar.

It was upon some such report that the last summer, the vulgar in general believed, in a country but twelve miles distant from me, that I always carried my dung and threw it into a river. Now there is no river nearer to the Barton, where my dung is made, than is the furthest of my land, so that the expense of losing my dung would be greater than spreading it on any part of my farm. Besides I live in a country where farmers buy dung at a good price; but it is known that I neither sell nor waste any dung. Against such lying tongues there is no defence.

And since all truths that are new are sure to meet with opposition, I do not think that any relation of my scheme of husbandry should be entirely depended upon; it is but hearsay and most commonly prejudice; but a man may be thoroughly satisfied by making and repeating the trials I have described; but then the whole process of them must be under his own inspection, which will be very little trouble or expense for discovery of a truth that may prove useful to the world. And as a gentleman who has any *goût* to agriculture may easily see these trials made, he ought not in justice to listen to the uncertain reports of others, especially of prejudiced persons, as all must be who endeavour to disparage what they have never done or seen, but when very many have made the trials, the truth will doubtless appear.

As for all the facts I have related as of my own knowledge concerning the whole scheme, they are true to the best of my knowledge and belief, and of this, if it were of any

use, I could safely make affidavit; but that would be now needless, since every one who will be at the trouble of making the trials, may have the evidence of his own eyes and reason in confirmation of those facts; and considering the general prejudice against things of this nature, he who is zealous for the truth in a matter of great importance, ought not by any insinuation of others to be hindered from making the trials himself, having always in mind the motto of the most unprejudiced searchers of truth, the Royal Society, viz., *Nullius in Verba*.

The prejudice of prepossession hath a strange influence upon the understanding, else the following could not be thought an argument of weight, viz.; Two lords talking together on the principles of agriculture agreed exactly in their sentiments; but an honourable young gentleman unacquainted with the subject, was heard to say, he wished their lordships were right in their notions: this wish, though natural and just, was looked on by some as a strong argument against my husbandry; but I cannot conceive how any prepossession could be strong enough to make it pass as such upon a person of distinction. Such a conclusion from such premises would scarce be drawn by the gossips at a country-bakehouse: though I am told it has by some polite philosophers that frequent the Bath.

In regard to our statutes that are a grievance to husbandry, I am far from advising any gentleman, who has a good tenant, to turn him out in order to practise agriculture, or rashly to change that scheme he doth already practise, if it brings him good crops, and the expense doth not run out the profit of them. But by all that I hear of, there are too many who do not enjoy either of these two happy circumstances; and I am afraid there will be, ere long, as things now go, very few or none that will enjoy them. I wish that time may not come before gentlemen have made themselves

perfect in the theory and practice of the most profitable agriculture, whatever it be.

I hope that if all the lands in England should necessarily fall into the hands of the owners, it would be no prejudice to the public, but the contrary : for then it is probable those statutes that were the occasion of the tenants leaving the lands, might be altered ; not according to the late printed proposals for a new Poor Act ; for that seems likely to ruin the greatest part of the lands ; it would take away too many of the hands from most of the parishes, and much increase the poor's tax ; but altered according to our laws that were in force before those statutes ; or according to such laws of our neighbouring countries, which give liberty to the owners of lands to keep them in hand with pleasure and profit.



NOTES ON THE PREFACE.

REASONABLE *to expect that an apology will be required for writing, &c.*—p. 1, l. 4.] For the Equivocal Society to charge me with audacious brags and pretensions to infallibility is very vile ; and the reader will see that the contrary to their accusation is true. But if he reads the Society's two volumes, he will see more of that kind, than is to be found, I believe, in any author, some of which I beg leave here to insert, viz., in p. ii. of their Dedication of their first Volume, they say of their treatise, that it is "one of the completest Systems of Agriculture that was ever yet published." In Preface to April, has "already obliged the world with some scraps."—p. vi., "A complete Set or System of Agriculture ; and being entirely new and deduced from practice, will be of great use to the public." In Introduction to April, "Shall publish something more to the purpose on Husbandry and Planting, than has yet been done, and from which (it is to be hoped) a more complete System of these Sciences may in a little time be formed, than has yet appeared in the world." In Preface to May, p. i., ii., "The authors, upon a serious and impartial view of all that has ever yet appeared, and well knowing their own integrity and designs, are not in the least intimidated from offering the following papers, till a general System is finished ; not doubting but that the world (though tired as it were with that numerous pest of books with which the press has been long crowded) will yet do justice to this or any other undertaking, which in so visible a manner appears to be calculated

for the public good, and wrote in a much more useful, well as more agreeable, style and method, than has yet appeared," &c. In p. iii. of the same Preface, "The author living much more in the country than in town, being of consequence much better able to judge of the ignorance of all country farmers," &c. In p. iv., "And from the knowledge of us, who are the authors of these Memoirs, we can affirm that the major part of the farmers of this kingdom, and we can almost say gentlemen too, know little or nothing," &c. In Essay for May, p. 137, "And though Mr. Miller hath gone a great way, the reader will find more for his instruction in this, than in any other book yet extant." In Dedication to Vol. II. "The authors, free from all sordid, servile views, think themselves very happy," &c. In Preface to July, p. iii., "Wherein not only the Practice, but the Theory also of those useful Sciences will be set in a stronger and more conspicuous light than they have ever heretofore been," &c. Much more of this sort of brags, arrogance, and presumption, may be found in the works of those authors.

The solicitations by letters from persons of rank, &c.—p. 1, l. 12.] Equivocus insinuates, that I write to show myself a great man and a fine gentleman by the conceitedness of my own opinions, and the like, which he would have the world believe the only motives of my writing.

Of the many persons that persuaded me to write, the Commentator and Translator of Virgil's Georgics was the first, who, both by word and a great number of letters, which I have, and by other inducements which I do not care to mention, solicited me to put my thoughts upon husbandry, &c., into writing; he often telling me, that he knew nothing in the world that would be of more general use, than my Drill, &c., if made public; there never having been any other of the kind that would perform that work to any purpose, as he believed, and he had read all the books he could obtain

ikely to discover them, if there had been any such instruments. He said the Sembrador was the nearest; but of a structure very different from my drill, and upon full trials was found useless for planting in rows, it being only designed for planting corn deep in land that was level, and so fine that neither clods or stones remained in it. He showed me the cut of Mr. Worledge's drill, which he said was only a proposal, and never made but in the cut. He also told me, that he himself had been endeavouring to get such an instrument made, and had employed a worthy Reverend projector, who put him to an expense of 25*l.* in making one for him, which, when finished, would perform nothing.

He afterwards desired, that my workmen might make him a drill of my sort for St.-Foin, and another for turnip-seed, which was done; and then he advised me to make that part of metal that was before of box-tree wood, and is in my plates described as made of brass.

It is to that ingenious Antidrydenian critic, that I chiefly owe my misfortunes of the press, which have been more and greater than I believe ever happened to any author on the same subject.

Perhaps you will say, I might have avoided these misfortunes by suppressing what I had writ; and, indeed, after the Specimen was published, I was come to a resolution of printing no more, for several reasons; the chief of which was, my apprehension of the mischief that would be done by pretenders, who were setting up in London; and that, when I heard my Specimen was reprinted in Ireland, I expected the whole book would be so too. But I was prevailed on to change my design by several letters, one of which I here make bold to insert, hoping the noble peer who wrote them will not take it amiss, since it is to obviate an objection injurious to the design of the same letter; which is as follows:

MY DEAR SIR,

London, February 8, 1732.

“ ——— showed me your letter to him of the 3d of this month. I am extremely sorry to observe from it, that you are under great discouragements at present. I hope you will believe I am very sincere, when I tell you I am much interested in your preservation, from the happiness I have of a personal acquaintance with you, as well as from the concern I think the public has in a person who has laboured so successfully for its service. I would fain hope, that the apprehensions you had from your spitting of blood are long before this time removed, by its having ceased. If that is the case, I must conjure you for the sake of your own glory, and for that of your country’s benefit, to apply heartily, and without loss of time, to the publishing of your work. If you cannot get an amanuensis from Oxon speedily, pray let ——— send you one from hence. I am persuaded the subscription-money will go far towards printing your book ; but if any thing should be wanting, you may be assured that your friends here will contribute towards having a work so beneficial communicated to the country, and in a way that the profit arising from the sale of your books shall return to yourself. The hardship that has happened you from the reprinting your book at Dublin might easily have been prevented, if we had foreseen that the thing was to have happened ; but now that we are aware of that inconvenience, you may depend upon it, your friends will either get a stop put to the printing from hence, or by the means of the authority of my Lord Lieutenant of Ireland.

“ I am ever, with great esteem,

“ My dear Sir,

“ Your, &c. ———.”

Glory is the reward of warriors, attained in the field of battle ; but in our arable fields, the master of them must be a slave to those people who are under the greatest obligations to serve him ; and slavery is opposite to victory. Indeed glory will belong to the Legislature, when it shall please to deliver masters from that slavery, which is so injurious to the public, and beneficial to no honest person. Until which happy time, we may say with the Poet,

- - - Non ullus aratro

Dignus honos - - -

For my part, I pretend to no other merit, but my endeavours to answer the desires of my friends, whose expectations, I am persuaded, were as reasonable as their promises were sincere, of which I am now able to make no better return, than by my acknowledgments and this Supplement.

If they had not believed the performance of those promises feasible, they would not have made them.

When I was honoured with those letters, I was (in all appearance) going out of the world, and far from having an ambition of acquiring any reputation, except that which nobody who regards truth can take from me, viz., that of being sincere ; and for being so in too great a degree through the whole course of my life, my friends have often reproved me, as it is a bar to most worldly acquisitions (though I should not have had other impediments), and since this is rather looked on by the polite as a disgrace, I have no apprehension of drawing envy upon me, but contempt on that account.

I likewise here insert one of the letters I received from Ireland ; it was from a Member of Parliament there. I only set the initial letters of his name.

“ SIR,

Dublin, March 4, 1731.

“ There is just now a Society formed of near two hundred of the chief gentlemen of the kingdom for the Improvement of Husbandry and Manufactures ; but principally the first, in order to introduce the best method of tillage and improving land ; and as you have been so great a benefactor to the public by the Specimen you have published, one of which I had from you last June, when I went to wait on you, and at the same time so obliging to walk and show me the proof of your method, which, as well as I could remember, I related to the Society, and had several of your Specimens reprinted here, which has raised a desire in every body that reads it to see the Treatise at large, with the several plans of the tools ; this alone will not be sufficient without a person be sent over that will show the use of them, who would meet with due encouragement. I am now desired by this Society to write to you, to have your consent to enter your name amongst us ; and to beg the favour of your assistance, to communicate your thoughts on the subject we are engaged in. The Earl of Halifax has done us this favour. The chief benefit proposed is to promote your good work among all the farmers of this kingdom, which is by nature very well adapted to all kinds of tillage, having all kinds of soils you have in England, except the chalk, of which here is none. You had a servant, when I was last in England, to wait on you, that did understand your method of tillage : if you can spare him, which I understood by you would be convenient about this time, he shall have what wages you think he deserves ; and he may at the same time bring over with him an entire set of tools. I desire the favour of your answer as soon as possible, directed to me at the Parliament House here, and you will much oblige,

“ Sir,

“ Your most obedient, humble servant,

“ G. M.”

In answer, I returned my thanks for the offer, and the reasons why I could not accept of it. And that there was not a conveniency of sending the engines from hence ; neither would the man venture his health in Ireland.

At length, overcome by the importunities of noblemen and gentlemen of South and North Britain, as well as of Ireland, I unwillingly printed and published my humble Essay, against which the Secret Society have exerted the utmost stretch of their dirty wit and invective : but it happens, their wit is so much inferior to their malice, that the sting of their satire (they designed against me) points only against themselves ; particularly their witticisms in their scurrilous Preface to August, p. xxxiii., &c.

I know nothing that could have induced noblemen and gentlemen to desire a thing so unreasonable of a person in my circumstances, as to become an author, except the reasons given in their letters, viz., that upon their ocular inspection of my husbandry, they were convinced it would be of general use, if publicly known and described ; which, on account of the newness of it, and of the instruments with which it was performed, they judged was impossible to be described by any other than myself.

From all this it may appear, that if mountainous expectations have been raised, it was by others ; and if they had produced only a mouse (as Equivocus would have it) I should not have been answerable for such a production's being disproportionable to those expectations, unless I had fallen short of what I had promised in my proposals, or the title of my Essay, as to both which I hope I may be justified, if such allowances be made, as every candid reader makes to the inadvertencies that sometimes happen to the pen of a person in pain ; because he cannot write but in a hurry.

The following are all the articles of my proposals relating to the account of the work, viz.,

I. In treating of roots it is proved, that they extend horizontally to a much greater distance from the stem than it is commonly thought ; and that they are in this, and in all other respects, by nature, adapted to receive the benefits of the horse-hoeing husbandry.

II. The natural and artificial pasture of plants are described.

III. It is shown how this artificial pasture is raised by dung and by tillage, and what difference there is between the one and the other means of raising it.

IV. That deep and proper hoeing is a sort of tillage that can supply the use of dung ; and that it is for want of this tillage, that few plants are brought to their full perfection.

V. The rules for putting this husbandry into practice are shown, as far as the author's experience reacheth.

VI. All the particular instruments, necessary for that purpose, are described in cuts by the inventor, with directions how to make and use them.

Had I failed of performance in any of these articles, though nobody else had taken notice of it, Equivocus would have been sure to upbraid me with it ; and for what I have done more than my proposals required on the subject, I hope my readers will not accuse me of breach of promise, for having exceeded it.

But as far as the sincerity of persons of honour and learning will go, and I hope that cannot be doubted, abating for some compliments of the polite, my Essay has their approbation ; at least the contrary hath not come to my knowledge.

Of many letters I have received of the same purport, I will here insert one that I would not have mentioned upon any other account than to show that Equivocus imposes a falsehood upon the public. The letter is from a noble peer, since deceased, who having had much experience of drilling, and

practised it, as I have heard, upon hundreds, or rather thousands of acres, beginning it for wheat, against my advice, almost as early as myself, had seen (by listening too much to his agents and servants) most of the errors in the practice; which (as I have been informed) were more than I could have imagined possible to be committed, though sometimes they did well; the different experience of right and wrong had enabled his lordship to form a juster judgment of the scheme in general, than any other could.

“ SIR,

“ *September 19, 1733.*

“ I have the pleasure to be studying your book; I have three of them, which Mr. ——— shall account with you for; but I think there is a great deal due (besides the price) for so great a treasure. My own thanks, as well as those of all England, will yet be too little, for what much better judges than myself esteem as the finest piece of natural philosophy that ever was wrote, besides the addition of your own experience and most admirable invention.

“ The more I read, the more I am convinced, that there is no other way of raising wheat to any advantage (or without loss) but by the drill and the hoe-plough. I am now strongly resolved to do what I have been too careless of.

“ Dear Sir, your, &c. ———.”

I am informed that the Dublin Society, mentioned in the inserted letter from Ireland, consisting of lords spiritual and temporal, and gentlemen of the first rank, are such a body that for learning and other qualifications was never equalled by any society formed for the improvement of agriculture in any part of the world.

My Essay has the approbation of that honourable Society, as appears on the titlepage of the copies reprinted by their order, and published in Dublin.

From the best judges, I beg leave to descend to the worse, in order to confront my enemies, the Equivocal Society, with their own approbation of the Essay they are hired to vilify and defame.

See the Practical Husbandman and Planter, p. iv. of Preface to August:—"We are very far from animadverting upon (much less censuring) every thing which that voluble author of horse-hoeing has advanced on the subject of husbandry and planting; having, on the contrary, made use of his arguments and authority, wherever we have found them agreeable to reason and experience; and in particular (as is to be found in the Preface to the last Monthly Essay) have quoted a good deal from him on the vegetable palates or tastes of plants, which the late Mr. Bradley and several other virtuosos have for several years last past entertained the world with, it being," &c. Here they spend several pages in transcribing from my 16th chapter. In p. x. of their Preface to July, they intimate, that a late voluble author, Jethro Tull, Esq., confuted an error of Mr. Bradley and Dr. Woodward, both of them F. R. S., and of the French author of "*Spectacle de la Nature*." In p. xii. of the same Preface, my antagonists own they are obliged to conclude with the author of the Horse-hoeing Husbandry, &c., quoting my Essay. In p. 25 of their Essay for July they have these words: "And here indeed the voluble author of the Horse-hoeing Husbandry has in all probability got the advantage of these two gentlemen [Mr. Bradley and Dr. Woodward], since as he argues with great probability of truth," &c. They here proceed to quote my authority in another material point in theory.

In many places of their Treatise, they commend the practice of drilling and hoeing, particularly in Essay for April, p. 32 and in p. 77, they say, "The new invention of drilling is of great use," &c. And the reason they give for it is,

“That weeds may be better hoed out, and the land kep cleaner from weeds between rows, than among that which is sown on a broad cast.” In p. 80 of Essay for April, they talk of turnips being generally drilled in by the drill-plough; and ask, why the roots of lucerne may not be hoed and set at equal distances as well as turnips? In Essay for May, p. 145, “And this [drilling] is indeed the best practice that hath been used, provided you can get the instruments proper for drilling and horse-hoeing.” In p. 149, of the same Essay, “Mr. Tull’s horse-hoe plough does the work very expeditiously.” In Essay for July, p. 134, “But if the farmer would drill in his wheat by a plough made for that purpose, one bushel [to an acre] will be sufficient, it being a truth, even beyond a peradventure, that wheat, especially on good land, is generally sowed too thick.

In Preface to September, they insert the following letter from a gentleman, part whereof I have extracted.

“B——, *Essex*, July 12, 1732.

“Mr. SWITZER,

“In answer to yours concerning the planting or setting of corn with proper instruments, and for introducing a kind of vineyard-culture in our fields, I acquaint you, that I have made diligent search amongst ancient authors, but cannot find any thing which seems to point that way, although it must be acknowledged to be a very pleasant, useful, advantageous method, in all well-cultivated soils; and in those years especially when corn and grass seeds of all kinds are dear, provided that there could be such instruments found out, which would be regular and punctual in the delivery of the seed at equal distances, being fully convinced, that the sowing of grain at random, and so thick as it used to be (whatever it is in grass), is yet in bread and other corn a very bad practice.”

But this gentleman says, he hath found amongst the modern authors Gabriel Platt (whom I have never read) to have fallen into this way of thinking. He relates from Platt the prodigious benefit of this sort of husbandry, which appears to be only the setting of corn by hand ; and as it seems to me his instruments were a sort of setting-sticks of iron, which in some places are called dibbles. Whatever they were, they could have no resemblance of mine, as the practice was inferior, as may easily appear by the gentleman's relation of it. He has the following paragraph.

“ And this method, which was partly put into practice in the year 1601 (when a little treatise of that kind was published), was in great repute ; but afterwards, when the price of wheat grew cheap, and labourers' wages grew higher, that practice ceased for want of more expeditious ways by instruments, which want the author of the Horse-hoeing Husbandry (with what success we are not able at present to say) has lately endeavoured to supply.”

The letter concludes thus :

“ I have read what Worledge and the author of the Horse-hoeing Husbandry have wrote on this subject ; which with my own observations shall be the subject of some other letter.

“ I am your assured friend and servant,
I. K.”

I hope this judgment of both strangers and enemies may be sufficient to justify the solicitations that procured my Essay to be written and published.

Much of the speculative part left out, if it had been more, it had been no great matter.—p. 2, l. 17.] Not that too much of it is possible to be written ; but because I had started more points than I had time and opportunity to write of so fully as I desired ; for in this matter I am of an opinion

quite contrary to Mr. Evelyn's, who blames the writers on husbandry for being too full in particulars, and for not writing on more points: he would have them be more in generals, and less full in particulars; which seems to me to have been the fault of every writer on this subject; and it is not much better than to be *aliquod in omnibus, in singulis nihil*.

But indeed many points started may, when enlarged on, serve for framing more hypotheses, as well as for strengthening those already framed: and they are so useful for discoveries in natural philosophy, that though they should be all of them in some part false, yet amongst them they bring truths to light, which without hypotheses might have never appeared.

I beg pardon of the learned writers from whom I am forced to differ in opinion, &c.—p. 3, l. 21.] The Equivocal Society accuse me with condemning all authors, pretending that I say in my Treatise, that all their books are fit for nothing but to be thrown into the fire; and that, in imitation of a certain nobleman, I had carried them on a hand-barrow and burnt them. But as I never have said any such thing, this falsity is a mere invention of that Society.

The story of the hand-barrow inserted in my Preface to the Specimen, being first told me of a Lord Chancellor, eminent both for eloquence and justice, by a person of rank, and since confirmed by others, I have no reason to doubt the truth of it: but for my part, I was so far from passing sentence on those authors, that I had, when this was first told me, read none of them, and not many of them yet; nor had I ever an inclination to burn any writings of agriculture, except my own, which I had certainly done, instead of publishing them, for my dislike of the style and manner of expression, different from the elegance of other authors, had it not been for the truths they contained, which, as I apprehend, were extant in no other.

I had no prejudice against the person of any author ; and have made no objection to their opinions without giving my reasons, which happen to be such as this bragging, boasting Society have not been able to answer in any one particular ; for which I appeal to the judicious reader of their two volumes.

But how differently this Society treat authors and their books, appears in many places of their Treatise, of which I will quote some, viz., in the Introduction to Vol. I. p. xiv., they say, "Lord Bacon, Hartlib, Blithe, Houghton and Mortimer fall extremely short," &c.—p. xv., "Want of experience in Mr. Laurence, who hath fallen very short of the title of his book." "Mr. Bradley's trifling repetitions of what was of little use," &c.—p. xxii., "Dr. Woodward, a closet philosopher."—p. xlvii., "Much rubbish in the translated foreign authors ; and in the Transactions of the Royal Society, and in Houghton's, Mortimer's, Laurence's, and Bradley's Works." In p. liv., "Mr. Evelyn is so full of erudition and learning, that there is scarce room left for practice ; besides, the works of Mr. Evelyn, how much soever we revere them, are somewhat immethodical and confused," &c. In Essay for July, p. 20, "The ancients were whimsically extravagant." And in p. 22, "Lord Bacon copied after them." In Essay for Aug., p. 14, "Dr. Lister speaks in such dubious, unintelligible terms, that it is difficult to collect any thing from him," &c. In Essay for September, p. 91, "Modern conceited coxcombs ;"—p. 92, "Empty conceited noddles," &c.

All this ill treatment of authors is little in comparison to what may be found in those pages wherein the books of all authors (I think none excepted) are affirmed to be worse than those of that Society ; or, which is the same thing, that the Society's books are better than theirs : this being a greater slander than any of the former, and fully proves by

the judgment of the Equivocal Society, that the sentence of the nobleman was just, which he caused to be executed on those books, with the hand-barrow and fire.

These System writers do not only vilify authors, but countries too; as in their Preface to July, p. xv., viz., they say, "For as they [the French nation] are a people of no solid attention to things, but run away with every plausible notion, it is no wonder they err so often as they do." In Essay for June, p. 78, "Fit only for Irishmen and clowns." In Essay for Aug., p. 27, "Only a detail of Irish jargon." In Advertisement to Vol. II., sots and ignoramus's are terms applied to the British nation by this Equivocal Society, who pretend to so much politeness.

These pretenders to agriculture, in Introduction to April, pp. xlviii. and xlix., presumptuously take upon them to direct the education of noblemen and gentlemen; they censure the Universities, condemn their learning, and opprobriously call their volumes of logic, ethics, physicks, metaphysics, &c., learned lumber, in which they say, "Time is spent to little or no purpose, and how well many young noblemen and gentlemen mend the matter by their travels abroad is but too obvious to most people who converse with them after their return; from whence, instead of fine well-turned Englishmen, they appear like dancing-masters, and formed only as if they were designed for theatrical performances."

But the greatest slander (except affirming themselves to be gentlemen) is the criminal charge of being my abettors, which crime they impute to noblemen and gentlemen of the first rank, who they say were my encouragers: their lawyer sure might have told his brethren of the society, that an abettor is a heinous criminal, that formerly used to be punished with death.

These authors have also had the presumption to prefix the names and titles of noblemen as patrons of their in-

famous libel, to which they are either ashamed or afraid to subscribe their own names; as if defamation, scurrility, and notorious falsehoods would be defended by persons of the nicest honour, politeness, and veracity.

The ill manners of these latent authors make it improbable that they are acquainted with the conversation of noblemen or gentlemen, any more than with university learning, which they term learned lumber, and so much despise that they seldom make use of any other logic, than that of Billingsgate in their system; instead of arguing against me like men, they fall to calling me names,—atheist, infidel, fool, *mente captus*, madman, ass, owl, viper, carping insect, &c. These are the feminine arguments of scurrility with which my antagonists endeavour to confute me. They scold like oyster-women, but never argue like philosophers, so great is their contempt of learning and the manner of all learned writers.

His partiality I have no reason to apprehend; because, &c.—p. 4, l. 3.] I did not then apprehend that any one man, much less a Society, could have had an interest sufficient to bias them in this decision.

Here it may not be amiss to inquire, what sort of men the Equivocal Society consists of? And the reader will easily discern them to be such who for want of (or perhaps being unfit for) more honest employments, have enlisted themselves in the service of certain tradesmen; and are, as Mr. Miller (in his proposals for printing his Dictionary) says, “Set to work by such whose business it is to watch and please the various tastes of their customers, and who never fail to oblige the world with treatises enough, upon whatever subjects they find most in vogue; and seem to think they have nothing more to do, than after having formed a titlepage that may strike the reader’s attention, to procure an author to write to it, however qualified he may be

for that particular subject, and who, on that occasion, generally takes his helps from what has been written before, being entirely unacquainted with the practice either of the past or present times."

They have, it seems, a numerous retinue of these hirelings, which they muster together in a band and call them a Society, when any considerable mischief is to be attempted by them; and such their masters allowed their undertaking to be, when they declared the purpose for which their army of penmen was raised, viz., to damn the Essay on Horse-hoeing, which, they afterwards said, they did not fear but would be effected; for that the best pens were at work in writing an answer to it; and this they soon published under the title of "The Practical Husbandman and Planter."

The cause the shopmen pretended for menacing war, was in effect this, that they thought they had a sort of right to the publishing of all books in their names; and to have the profit of selling them (if any be) which they seldom own, but generally complain of loss by them.

But the reason of this extraordinary indignation is given in the beginning of the Pref. to Aug. in the following words. "Amongst all the Essays which have for these many years last past been wrote on husbandry, there is none that has raised the expectations of the curious to that great height before it came out, as that of the Horse-hoeing Husbandry, said to be wrote by Jethro Tull, Esq. of," &c.

They seem to take great liberties, because there is no Dedication of my Essay; the reason of which omission was, the Queen having done me the honour to subscribe to my book, I could not dedicate it to any other person; and her Majesty's royal virtues being too far above any panegyric I was able to write, I chose rather to leave it to the protection of the royal license and the laws.

If you would have the true character of these boasted able

penmen ; see in the last page of their Preface to July, their dubious description of themselves in the following words. " Nor can we guess whether of the two, those who pick a pocket, or pirate another man's works (without acknowledging from whence they extract it) are the most notorious criminals."

It would not be difficult to prove the Secret Society guilty of pirating other men's works, without acknowledging from whence they extract it, and in particular some of Dr. Woodward's, and some of mine.

They also are no better than pirates, who publish a considerable part of another man's works, in prejudice to the sale of his book : in this manner have the Society pirated a great part of the Rev. Mr. Hales's Vegetable Statics, and some of his Plates. And if all they have taken from others in this manner were extracted from their two volumes, I believe nothing would remain of their boasted system, except the relation of false facts which they affirm to be true, and the true ones they pretend to be false, their opprobrious, scurrilous language, and nonsense ; for they have not only renounced common honesty, but common sense too.

By the manner of their proceedings, they seem to resemble a modern gang of footpads more than pickpockets ; they are not content with robbing a man of his property, but they use him barbarously too ; they wound or murder his reputation, which, to a gentleman, is more valuable than life ; whereas pickpockets are generally content with handkerchiefs, snuff-boxes, or such trifles ; they are therefore less notorious criminals than the Secret Society.

A libel is a crime against the peace, as it is a provocation to the breach of it ; but the Secret Society conceal their own names whilst they level slander at mine : like the cowardly Italian banditti, who conceal their own persons behind a rock when they discharge their volleys at a defenceless traveller.

As to their pretended General System of Agriculture, they made the most mountainous promises that ever were heard of; but what have they brought forth? Why, not a mouse, indeed, but a scorpion; which is a poisonous insect, the wounds of whose venomous teeth are cured by the juices expressed from its bruised body: so the (libel or) Equivocal scorpion is full of contradictions, one of which, if rightly extracted, is an antidote against the poison of its opposite: a short specimen of those contradictions here follows, viz., 'They accuse my Husbandry of novelty and of being crazy and new-fangled, and yet say it was put in practice above 130 years ago. They extol the conduct of the ancients, and yet say they were whimsically extravagant. They say I am a *mente captus*, and yet quote my authority, and pirate part of my book. They pretend to prove by an inserted letter of J. K. that I am not the inventor of my husbandry instruments, but that very letter proves that I am.

The Practical Husbandman contradicts the title of his book, when in p. x. of his Pref. to Aug. he shows that he doth not know ploughing from harrowing, and it may be thence inferred he doth not know a plough from a harrow; as it may be inferred from p. xxxii. of the same Preface, that he doth not know my drill from Platt's setting-stick, nor my hoe-plough from the sheim of Kent. His title should have been The Cockney Husbandman, who never practised agriculture out of the sound of Bow-bells: as appears in the system which yet the Society affirm, in p. ii. of Pref. to April, is not collected out of books, but is chiefly the result of practice itself.

Note, I do not suppose any of their letter-writers to be of the Secret Society, except the lawyer I. B. who owns himself (a degenerate to his profession!) to have had a share in writing the scurrilous Preface to August.

The matter of fact I have related.—p. 5, l. 13.] It would

have been rather against my interest than for it, to relate any fact falsely ; none being acted at so great a distance, or with such privacy, but that any one who would take the pains might satisfy himself, as several noblemen and many gentlemen did by ocular inspection.

It is true an *ipse dixit* in speculative matters is of little weight ; but of such matters of fact as Equivocus says (if he says true) that nobody knows but myself, what other proof could I give ?

Or if he doubt, it cannot cost much to satisfy himself by proper trials.—p. 6, l. 8.] But then he must take special care that his trials be proper. I do not advise any one to be at the expense of my instruments for that purpose, but to imitate them in pulverising and all other directed operations by the spade and common hoes. His ridges of experiment need be no longer than six feet. Instead of a drill make use of a triangular piece of wood, seven feet long, and four or five inches thick, with one edge of which make channels, and place the seed regularly even into them, by hand, and cover it with the same piece of wood ; but if the earth be so wet as to cling to the piece, then make use of it only as a ruler whereby to make the channels straight with a stick.

Let some of the ridges have double rows, others triple ; and let some have triple rows half way, and leave out the middle row in the other half, to show whether the double row or the triple row produce the better crop.

Then for the first time of hoeing, the spade must work with its back towards the row. The second time in turning the earth to the row, the spade's face must be towards it. These two, and several other hoeings should be deep ; but when the roots are large (and the hoeing is near the plants) the spade must go shallow, and neither the face nor the back of it must be towards the row, except when the earth is turned towards it, and then the face must be always towards

it; but for the rest of the last hoeings, the spade should work with its face towards one or other of the ends of the intervals, that the fewer of the roots may be cut off, and the more of them removed and covered again. Let the spits be thin for the better pulverising of the mould. The hand-hoe will sometimes be useful in the intervals, as well as in the partitions.

Four or five perches of land may suffice for making proper trials.

The expense of this will be little, though perhaps ten times more than that which is done by the proper instruments for the same proportion of land.

But I must give this caution, that no part of it be done out of the reach of the master's eye; for if it should, he may expect to be disappointed.

The richer the land, the thinner it must be planted to prevent the lodging of corn.

The master ought to compute the quantity of seed due to each perch at the rate of five or six gallons to an acre, by weighing, &c., as I have shown in my Essay.

I cannot commend more than two partitions in a row, or more than one when the intervals are narrow; because, the broader the row is, the more earth will remain unpulverised, under the partitions; too much of which earth being whole, will disappoint, at least, one of the differences mentioned in my nineteenth chapter.

Indifferent land I think most proper whereon to make the experiment, and the most improper for corn is barren land, as the best brings the largest crops.

To ascertain the quantity of the crop, take a yard in the middle of a ridge, and weigh its produce.

Every year leave one interval unhoed, to prove the difference of that side of a double or triple row next to it, from the other side next to the hoed interval.

But it must be noted, that the spade does not always pulverise so much as the plough or hoe-plough; therefore there may be occasion for more diggings than there would be of horse-hoeings.

One of the observations that put me upon trials of wide intervals, and horse-work for corn, was the following, viz., One half of a poorish field was sown with barley, the other half drilled with turnips, the rows thirty inches asunder, at the proper season, and twice hoed with a sort of horse-hoe contrived for that purpose (but nothing like that I have described), the drill beginning next to the barley, left an interval of the same thirty-inch breadth between the first row of turnips and the barley, which being sown on large furrows came up in a sort of rows, as is common for barley to come when sown on such wide furrows. This interval between the barley and the turnips had the same hoeings as the rest, and had this effect on the broad row of barley next to it, viz., each plant had many stalks, it was of a very deep flourishing colour, grew high, the ears very long, and in all respects the barley was as good as if it had been produced by the richest land. The next row of barley had some little benefit on the side next to the strong row; but all the rest of the barley, either by the too late sowing of it, the poverty of the soil (not being in any manner dunged), or else by the coldness of the land, or coldness of the summer, or by all of these causes, though pretty free from weeds, was exceeding poor, yellow, low, thin, and the ears were very short and small.

I intended to have taken the exact difference there was between the produce of this outside row and one of those that stood out of the reach of the hoed interval, but I was disappointed by my neighbour's herd of cows, that in the night broke in just before harvest, and eat off almost all the ears of the rich row, doing very little damage to the rest,

except by treading it. It must be from the different tastes, the one being sweet and the other bitter, that they make their election to eat the one and refuse the other.

This accidental observation was sufficient to demonstrate the efficacy of deep hoeing, which I look upon as synonymous to horse-hoeing.

I immediately set about contriving my limbered hoe, finding all other sorts insufficient for the exactness required in this hoeing operation: those drawn in any other manner, when they went too far from the row, and the holder went to lift the plough nearer, it would fly back again, like the sally of a bell, and go at no certainty, not being subject to the guidance of the holder, as the limber-hoe-plough is. The Michaelmas following I began my present horse-hoeing scheme, which has never yet deceived my expectations, when performed according to the directions I have given my readers. And the practice of this scheme proves the advantage of deep hoeing, by the ends of the ridges and intervals: for there, whilst the drawing cattle go on the headland that is higher, the furrows are shallower, and the corn of the rows is always there visibly poorer in proportion to that shallowness.

Another proof of the difference there is between deep hoeing and shallow is in the garden, where a square perch of cabbages, the rows of which are three feet asunder, the middle row of them having the intervals on each side of it deeply and well dug by the spade at the same proper time, when the rest of the intervals are hand-hoed; this middle row will show the difference of those two operations; but in this must be observed what I have here before mentioned, of turning the back of the spade to the plants, to avoid the total removing them, especially in very dry weather.

This experiment has been tried, and always succeeds, with every one that has made the trials.

But before any one makes his trials of my field scheme, I would advise him to be master of the Treatise, by making an Index himself to it: this will both direct him in his proceedings, and show him the rashness of those who go into the practice of my husbandry without the necessary preparation; for they that do so now, seem to act as rashly as they that went into it before the Treatise was published. It is reasonable to presume that such their practice must be either different from or contrary to mine.

This Index may be also useful for discovering pretenders by an examination, without which gentlemen are liable to be imposed on by them, as I am afraid too many have been; for amongst all those who have undertaken the management of my scheme for noblemen or others, I declare I do not know one person that sufficiently understands it: there may be some who have seen, or perhaps performed, some of the mechanical part; but I do not think it can be properly performed without a thorough knowledge of the principles, which cannot be expected of such illiterate persons, and yet is necessary for the proper applications in different cases, which cannot be distinguished by pretenders; therefore until the scheme becomes common, the management must be under the direction of the master himself, or of one who has past his examination, and is faithful.

The particular scheme, &c.—p. 7, l. 10.] There is now the eleventh crop of wheat on the same field (except that in the ninth year, by accident of having contracted to let my farm, it was drilled with white oats), and I do not as yet see any reason against its being continued for wheat annually, as long as it is kept in this culture.

A single crop.—p. 7, l. 34.] Is one which is not to be repeated the following year by another crop of wheat.

Two shares, thirty inches asunder, &c.—p. 8, l. 2.] But if due care be taken by the driller to guide his horse as he

ought, there will be no occasion of any other drill for that purpose than the triple one, taking out its foremost sheat, and setting the two beams at the same distance from each other's middle, that the partition is to have breadth; and setting the marking wheels to the size of the ridges. And this I have fully experienced since I wrote my Essay.

Other vegetables, such as, &c.—p. 9, l. 10.] Such seeds as are unfit for drilling whilst in the husk, must be taken out of the husk by the mill or the flail.

What pretenders or impostors have taught or said of this husbandry, &c.—p. 9, l. 15.] Both these have been very injurious to it. By pretenders, I mean such who, having seen somewhat of the drilling scheme, without understanding it, set up for masters, made great numbers of my engines (whether any were very good I know not), gave directions for using them, and took upon themselves the whole management, in opposition to me, who they knew was not able to appear against them. To some they pretended to be inventors, and to those who knew the contrary they pretended they acted by my consent and approbation. I could not but foresee the mischief likely to ensue from their follies when I heard of them.

They advised the drilling of St.-Foin upon land that was wet too near the surface in winter, and had been planted before with that grass, and it died in the winter, and so did that which they drilled. This was great folly in the pretenders, because every new thing that miscarries in any part is a disparagement, though the miscarriage be not from the thing itself, but from the misapplication of it: so was this, for the cause was in the improper land, not in the drill (if I was told truth); the St.-Foin came up very well and even, and that is all that can be reasonably expected from the engine. Their directions about drilling of corn were likely to be as vain and ineffectual. To prevent the ill conse-

quence of their proceedings, I did all that was in my power by letters ; but for want of being present in person, those endeavours proved unsuccessful, though backed by a noble lord, who knew my integrity, and the vanity of those pretenders, by his own experience ; and what was the worst misfortune of all, one of the pretenders (I may say the chief) was a person, for opposing of whom I was blamed and ill thought of even by those I would have secured against suffering by his follies, which I opposed.

They who had made trials by the directions of any pretenders before my Essay was published, can have made no trial of my husbandry ; and consequently could not reasonably expect the success of it, unless by a miracle the effect should be produced without the cause ; and who have been thus deceived, may, through a causeless disgust, as rashly desist (and deter others) from proceeding further when they have my directions, as they began without them.

I saw in one of Mr. Ellis's books an account of an experiment, which, to the best of my remembrance, was as follows ; viz., A farmer ploughed his ground in furrows at eight feet asunder, and into them sowed beans by hand ; then he hoed these monstrous intervals with a wheel-plough, which could not, I am confident, plough much nearer than two feet from the rows ; so that the bean roots were not likely to reach the hoed earth through such a distance of unhoed hard land, which was sufficient to produce weeds that would starve the beans ; and for the rows themselves, they were probably so broad and irregularly planted, that it must be difficult to pull the weeds and grass from amongst the beans : they could have no more benefit from such hoeing than if it had been performed in an adjoining field : the event of such rash proceedings is not hard to guess at, though Mr. Ellis had told us that a very indifferent crop of beans was produced ; and yet this is by the ignorant judged as a trial of horse-hoeing.

As I live obscure from the world, I am not apprised of all such trials that have been made, nor of any but by accident: yet I am persuaded that he who consults my Essay will judge all examples of equal rashness to be for want of consulting it.

To send them servants to instruct them in it, &c.— p. 9, l. 25.] Since I began my scheme I have not had one whom I could recommend for that purpose. Hired servants are arrived at such a pitch of exorbitant power and conceit, that they think it an affront to be put out of their way, and therefore pretend they cannot do what they are only unwilling to do.

An instance of this, I am informed, happened in the case of a nobleman (well skilled in agriculture) who had two arable estates in his hands; on that which was near the place of his lordship's residence the four coultered ploughs had been used with success; his lordship therefore sent some of the same sort to his other estate, which was a day or two's journey distant, with orders for his servants to use them there in like manner; but a while after, my lord going down to see how those ploughs had been there employed, he found that not one furrow had been ploughed with them. It was in vain to be angry at the disappointment; for bailiff and servants, steward and all, affirmed, that though those ploughs might be used on the other estate, yet the land of this was so different, it was impossible to plough with them here. No argument his lordship could urge to convince them of their mistake prevailed, because they were resolved not to be convinced; till at last my lord came into the field, set the four-coulters with the wedges himself, threw off his coat (and ensigns of honour), then ploughed a whole land, or great part of one, with this plough; at this the ploughmen were so ashamed, that they condescended to plough well with the four-coultered ploughs. It was their will, not their skill,

that was wanting before. Also several farmers have had these ploughs, and their ploughmen can easily plough with them ; but when the master is out of sight, they either throw the three foremost coulter into the hedge, tie them up under the beam, or else set their points above the ground : in which last case, if they see the master coming, they stop their horses, and pretend to be wedging the coulters. By this may be guessed what will be the case with my other instruments, where the master expects to be taught by servants.

That few gentlemen can keep their lands, &c.—p. 9, l. 32.] But it is feared the three statutes, which now in a manner prohibit them to occupy their lands, will ere long compel them to it, by prohibiting renters, whose patience and substance are so much diminished, that a scarcity of tenants that can pay their rent is already complained of.

The disreputation, &c.—p. 10, l. 16.] To gentlemen are owing all (or most of) our improvements in agriculture, notwithstanding the disadvantages they have in respect of their price of labour different from that of the labouring farmers, it being a common maxim, that the rent of arable land is the odds between saying to the hirelings, “Go, do it,” and saying, “Come, let us do it.” And the disadvantage even of the farmer, now is to pay (if he hires it) two years’ rent for the same labour that forty years ago was reckoned at but one year’s rent, though the price of corn and other provisions be lower now than it was then ; and indeed we find that the price of labour rises in proportion to the cheapness of corn ; the lower that is, the higher is the price of labour ; and when those hirelings have raised their price, they seldom or never abate of it. I wish therefore (as far as is consistent with the public good) gentlemen had such automata, until the three statutes that make them needful are made effectual to the purposes for which they were designed ; and that it is feared will be impossible, without

first repealing them, and then making all three into one, to be so executed that gentlemen and other freeholders may not be wronged in person, lands, or goods, by trials at discretion, against the common law.

Make the improvement by St.-Foin the greater.—p. 12, l. 1.] What added to this improvement was the exorbitant price of labour, of which a vast quantity is necessary to corn more than St.-Foin, though the product of the latter was of more value; but there is now a great alteration in both, as to the quantity of labour, and price of the product. At present the labour of making hay costs triple to what it did formerly, whereas the labour of arable land costs only double. The haymakers, till within these few years past, used to work on the hay as late in the evening as was convenient for the well making of it, which is often till between seven and eight o'clock, which is the time expressed by the statute: but now they have taken upon them to make what laws they please in this matter; they have limited the hour for leaving work to six o'clock; and thus, when they have a fancy to leave off, they say it is six o'clock, though but five; and I have seen them going home at four, when they did not begin till nine or ten in the morning, and rest a good part of the day besides.

This only increases the price of labour; but, what is much worse, the hay is in great danger of being spoiled by the neglect that loseth the benefit of the evening sun. And although the hay be all spoiled by such neglect, the wages, how extravagant soever, must be immediately paid, or the owner will risk being sent to the house of correction, as the law now stands.

Another thing that lessens this improvement in the country where I live, is, that artificial grasses are grown so common, that hay which used in dry years to be sold at three pounds per ton, is now not vendible, nor ever likely to be again in

any considerable quantity. St.-Foin seed, too, partakes of the fate of hay. I had planted fifty acres of St.-Foin on purpose for seed, in a manner that would have delivered me from the greatest inconveniences that attended the management of a large quantity, the worst of which was the danger of being by moist weather kept in the field until corn-harvest. To avoid this, I planted it in double rows, with partitions of eight inches, and intervals of about thirty inches for horse-hoeing, by which means the plants being very strong, bring their ears all of a pretty equal height, so that they may be reaped off as soon as ripe, at a small expense, and easily dried and laid up long enough before harvest, as well as the hay mowed, which, keeping the leaves on, must needs be much better than that which is thrashed. This would have brought me four times the rent of the land, but now most farmers know how to cure this seed, and raise it themselves for their own use, and seed is no more vendible than hay: therefore I have neglected to hoe these fifty acres, which yet supply me with hay enough for my cattle, and I have ploughed up all the rest; and when I have planted more in a proper manner for hay, I shall plough up this too, and depend upon corn only, as the best product of my farm, since more hay than enough for my working cattle and necessary milch kine is of no value to me, as I do not understand the difficult art of a grazier. If any one upon view of this should be offended at the wide intervals, he is here advertised, that it was not so planted on purpose for hay only, but for seed: and yet when the grass is ready to be mowed, the intervals of the greatest part of this St.-Foin are scarce visible, and the crop is good.

May also hand-hoe between the nearest rows, &c.—
p. 12, l. 16.] By this means the farmer may, if he has plenty of hands, remedy the only evil (except the expense) of his dunghill. But can tell him upon full experience,

that if he drills his rows nearer than at a competent distance, his crop will be diminished, as well as his labour increased.

ANSWERS TO OBJECTIONS, &c.

I AM yet apprised of no other objection as to the husbandry itself, material enough to deserve an answer; but there are several objections which indirectly relate to the putting it in practice, which do not justly belong to the husbandry, viz., it is said that workmen do not care to undertake the making of the drill, though it is by all allowed to be fully described. How then can it be difficult for a gentleman to direct the making of it by these descriptions, when one but meanly qualified took it from the organ, and thus fully described it?

It is said that gentlemen's servants, and bailiffs, do not care to put the husbandry in execution. Why should not their servants execute it better than mine do, since a person in health may better command his, and attend them oftener than I can mine?

It is objected that gentlemen will not take the trouble of studying it. The same objection may be made to algebra, navigation, or any other art or science; yet can be no reasonable objection against it, but only against the unreasonableness of him who would understand it without the necessary trouble of studying it.

Some have thought it an objection against the husbandry, if all the neighbourhood where it is practised do not immediately come into it; on this inquiry they lay a great stress: but they may as well inquire why the people of Madrid or Lisbon do not turn Protestants when some English live there and converse with them; for there doth not seem to be more prejudice (especially amongst the vulgar) in matters of religion

than of agriculture : in both the question is not, whether a different religion or a different agriculture is most reasonable, but only whether it be different ; and if it be, those who practise that which the opposers call new, are sure to be treated as the Secret Society treat me ; or as Protestants are treated in Popish countries, where the priests, unable to confute their arguments, misrepresent both their principles and their persons ; they term them heretics, and paint them as monsters with toad's claws, instead of hands and feet (this have I seen in the Jesuits Church at Naples.)

The Secret Society likewise are not content with abusing my vegetable principles, and terming me an Atheist, but also describe me by the similitude of the most odious, despicable, and pestiferous animals. They also usurp the power of the Inquisition of damning books because not their own.

Besides, it may be difficult to find the truth of facts upon such an inquiry ; the persons in possession of tenets, be they ever so false, will endeavour to support them by any methods of misrepresenting their opposites, rather than quit the notions they have received from long custom, perhaps without ever inquiring into the reason of them.

Whatever accident, even from the heavens, as lightning, tempest, a wet harvest, or from cattle, or the like, happens to drilled corn, it is sure to be imputed to the drilling ; though sown corn be as much or more damaged by it.

But the oldest misrepresentation was to the eyes of a stranger, who was shown a field for drilled wheat which was neither drilled nor sown, but shattered at harvest, and ploughed in before the leasers had picked up the ears ; it was about six or seven years ago, after a general blight, which had made the straws rotten, so that many ears were broken off in reaping ; but in some parts of the field more than in others. The intervals being ploughed at two furrows, for a succeeding crop of wheat, were found too narrow for

that purpose ; and therefore the whole piece was left with design to be planted with barley in the spring : but the shattered wheat coming up pretty thick in most places, it was, instead of ploughing, horse-hoed, but not properly, because the wheat coming up irregularly all over the two furrows, there was not half room enough for proper hoeing, though much of the wheat was unavoidably ploughed up by the hoe-plough ; but yet by being thus hoed pretty often, the remainder of the wheat that was not ploughed out became strong ; and was such a crop, that at the price wheat was then at, did more than answer the expense and rent of the land : but it was abominable for any one to show it to a stranger as a crop of drilled wheat, on purpose to deceive him. Many more of the like misrepresentations may be expected from people who are enemies to every thing that is different to what they are accustomed to practise.

As to what concerns my own interest, I know no odds it will be to me, whether any body except myself shall practise any parts of my husbandry, or not : I never went about to make proselytes to my principles, except by what I have written at the request of others. But as yet I do not find any objection has been made against them ; besides those in the Supplement answered ; which is all, I hope, that is incumbent upon me to do for them who desire to practise.

Some who, if I should name them, would be allowed as good judges of such matters, have, upon a full view and examination of the practice of it, far distant from me, declared their opinion, that it would one day become the general husbandry of England : but whether it may or not, I cannot pretend to divine ; nor doth it any way concern me. If it be ever common it must be made so by gentlemen, as other improvements have been ; the chief whereof is, I think, said to be the introduction of sowing foreign grasses, and which was so long before it became common amongst far-

mers, that though Mr. Blithe wrote of it in Cromwell's time, yet but thirty years ago, when any farmer in the country where I live was advised to sow clover, he was certain to say, gentlemen might sow it, if they pleased: but they [the farmers] must take care to pay their rent. As if the sowing of clover would disable them from paying it; and now the case is so much altered, that they cannot pretend to pay their rent without sowing it, though the profit of it was vastly greater before it was common than since; nor was there any difficulty in the practice of it, any more than the sowing of seed among their corn, as they saw done for gentlemen, for fifty years before them: and the improvement itself was at the first no more than doing the same thing on this side the water, that was done before on the other. The same was the case of St.-Foin, as of clover, St.-Foin having been in England almost one hundred years, and is become common but very lately. The drilling husbandry seems likely to have a much speedier progress, if my enemies, the Secret Society, are right, when they, in *Essay* for April, p. 86, talk of "drilling lucerne by the drill-plough, as turnips generally are." If turnips are generally drilled already, drilling has made a quick progress; for there never was (that I can hear of) any engine made for drilling of turnips, clover, or other small seeds, before the year 1720. And it was some years later that my vineyard culture was first begun to be practised on wheat; which is not a fourth part of the time that the clover improvement was commonly neglected after begun.

And this sort of new hoeing-husbandry being so different from the old husbandry, it may be expected (like most other inventions) to be imperfect in the beginnings, especially when practised by those who are strangers to it. The greatest reason I have to believe it may be common hereafter, is, that no good reason has been given (which I am apprised of) why this hoeing should not be beneficial to corn and other vegeta-

bles upon the same accounts as it is to vines. I am sure in all my experience of the practice I can find none.

Among the answers of this Note, I am afraid one will be expected, why I answer anonymous writers of scurrility. Perhaps I should not have taken any notice of them, if my name had been set to my Essay; but I have now taken notice of them for two reasons. First, To prevent their imposing upon the public, especially the vulgar. Secondly, As their wages is supposed to be low, their masters find them in tools to work with, their shops being fully stocked with books of all the authors who have writ on my subject, an account of which the journeymen have published; I have taken this opportunity to answer all their opinions that interfere with any material part of my theory or practice: those books are so numerous, that it would have cost me too much money to purchase them, though I should have had a catalogue of them, as I never had heard of half their names or titles.

My Preface to the Specimen published in 1730-1, not being reprinted in England, is not likely to be in the hands of every reader of my Essay; therefore I insert some parts of it; First, to show that what I have said of the hand-barrow has been misrepresented by my enemies. Secondly, the part that relates to the drill; and Thirdly, some of the cautions I have given against going rashly into the practice of the horse-hoeing husbandry. The first is as follows:

Writing and ploughing are two different talents; and he that writes well must have spent in his study that time, which is necessary to be spent in the fields, by him who will be master of the art of cultivating them.

To write then effectually of ploughing, one must be qualified to write learnedly.

Scarce any subject has had more of the ornaments of learning bestowed on it, than agriculture has, by ancient and modern writers; but a late great man, who was the Cicero of this age, having perused all their books of husbandry, ordered them, notwithstanding all their eloquence, to be carried upon a hand-barrow out of his study, and thrown into the fire; lest others should lose their time in reading them, as he had done.

He declared he could not for his life guess what those authors would be at; for they treated of an art wherein they had formed no manner of principles.

Now if these learned volumes, so elegantly written, and so little to the purpose, had done nothing but mischief, it is time that something should be written different from them in both respects.

How far I am capable of performing such a task in one of these respects, this part of my Essay will show; but what I have done different from them in the other of the two respects, cannot be fairly judged of before the whole appears.

(The Second Part concerning the Drill.)

I should not trouble the reader with an account how accidentally it (the drill) was discovered, were it not to show, that the knowledge of a thing which seems despicable or impertinent, may unexpectedly become useful at one time or other.

When I was young, my diversion was music: I had also the curiosity to acquaint myself thoroughly with the fabric of every part of my organ; but as little thinking that ever I should take from thence the first rudiments of a drill, as that I should ever have occasion of such a machine or practise agriculture; for it was accident, not choice, that made me a farmer, or rather many accidents which could not then possibly be foreseen.

It was my chance afterwards to have a large farm in hand, which I could not well dispose of; and it being about the

time when plough servants first began to exalt their dominion over their masters, so that a gentleman farmer was allowed to make but little profit of his arable lands; and almost all mine being of that sort, I resolved to plant my whole farm with St.-Foin; but the seed of it being scarce, and dear, and very little of it good, I found it would be very difficult to procure a sufficient quantity to sow, at seven bushels to each acre, which were usually sown. Whereupon I began to examine whether so great a quantity of seed was absolutely necessary; and whether the greatest part of the seed sown did not commonly miscarry, either by its badness, or from being buried too deep, or else lying on the ground uncovered: and I observed in several fields of St.-Foin, sown with that proportion of the seed, that in those parts of them which produced the best crop, there were (as I counted them when the crop was taken off) but about one plant for each square foot of surface: and yet the number of seeds in seven bushels sown on each acre, being calculated, amounted to one hundred and forty to each square foot; and what was yet more observable, in other parts of the same fields, where a much less number of seeds had miscarried, the crop was less. Then after I had learned perfectly to distinguish good seeds from bad, and had, by many trials, found that scarce any, even of the best, could succeed, unless covered at a certain exact depth (especially in my strong land) and had also found the reason of this nicety, I employed people to make channels, and sow a very small proportion therein and cover it exactly.

This way succeeded to my desire, and was in seed and labour but a fourth part of the expense of the common way, and yet the ground of seed was better planted.

Ten acres being so well done, I did not doubt but a thousand might have been as well done in the same manner; but the next year as soon as I began to plant I discovered that

these people had conspired to disappoint me for the future, and never to plant a row tolerably well again : perhaps jealous, that if a great quantity of land should be taken from the plough, it might prove a diminution of their power : I was forced to dismiss my labourers, resolving to quit my scheme, unless I could contrive an engine to plant St.-Foin more faithfully than such hands would do.

To that purpose I examined and compared all the mechanical ideas that ever had entered my imagination, and at last pitched upon a groove, tongue, and spring in the sound-board of the organ. With these a little altered, and some parts of two other instruments as foreign to the field as the organ is, added to them, I composed my machine. It was named a drill ; because when farmers used to sow their beans and peas into channels or furrows by hand, they called that action drilling.

It planted that farm much better than hands could have done, and many hundred acres besides ; and thirty years' experience shows, that St.-Foin, thus planted, brings better crops, and lasteth longer than sown St.-Foin.

This drill has also been used almost as long in planting most sorts of corn for hand-hoeing ; and these last nine years for horse-hoeing.

I am surprised to hear that some gentlemen pretend I brought the instrument from France or Italy, when it is well known it had planted two farms with St.-Foin before I travelled, which was not till *April*, 1711, being above ten years after making and using my drill. The praised commentator on the Georgic can testify this, he having twenty-seven years ago seen the fields of my last farm planted in rows by it. I gave one to a neighbour, who used it in his fields every year whilst I was abroad ; and it would be strange if I should bring it from countries where it never was.

I could bring a multitude of undeniable testimonies to

prove myself the sole inventor; but as I am no patentee, nor can have any benefit, but rather loss by publishing the invention, I should not care who took it upon himself, were I not apprehensive that some ignorant impostor, pretending himself the inventor, might by that means impose upon the world in vending a false useless engine for a true one; his conceited workmen will be still improving one part or other of it, till it will perform nothing, after having performed well *for almost forty years*. And then the invention being lost, who will have recourse to my cuts for restoring it, if I am not known to be the inventor?

But I own I took the first hints of my *horse-hoeing culture* from the ploughed *vineyards near Frontignan* and Setts in Languedoc; and after my return to England, having land come to my hands, I improved those hints, by observing that the same sort of vineyard tillage bestowed on potatoes and turnips had the same effect on them as it had on these vines. And then the mentioned row of barley adjoining to the horse-hoed turnips confirmed me in the principles, which, by arguing from effects to their causes, I had formed to myself; and my practice ever since has been a further confirmation to me of the truth of the same principles.

Thus I must acknowledge to owe my principles and practice originally to my travels, as I owe my drill to my organ.

(The Third Part is of the Cautions, as follows :)

For my part, if I knew any substantial objection against this husbandry itself, I would not conceal it; but I declare I know of none such. Yet I know there are many objections against its being practised by those who do not understand it, therefore I have never advised them to attempt it; but I have dissuaded them as much as I could against drilling great quantities of wheat, before their own practice, in small pieces, have made them perfect in this method, by

having the principles which are necessary to direct them in it ; for as wheat is generally the most profitable crop, so it requires the greatest circumspection in the management.

For some other crops, such directions might be given that would require no more but faith to execute them ; but so many various circumstances usually occur in the long time that wheat ought to live, that I think one can give no bare directions in them all, before they happen, but what may endanger the deceiving of the person they are intended to serve, unless the principles themselves accompany those directions.

Some perhaps may suppose these principles to be very numerous and prolix, because they cannot be written so easily as directions which result from them ; though, in truth, they are not so, for a few lines would contain them all, if they had received the approbation of proper judges. In the mean time, they are either so new or paradoxical, that I cannot without great reluctancy write any of them separately from the arguments I bring to support them ; and no man can judge so impartially in his own cause, or of his own arguments, as another who is unconcerned may. However, when they are published, every farmer that approves them makes them his own ; and then, whether he uses or abuses them, he cannot, I hope, justly blame me for his conduct.

What I most apprehend is, the rashness of those who shall enter upon the practice of drilling wheat, before they are sufficiently informed concerning it, for they cannot avoid being liable to many errors.

I would gladly save my brother drillers the expense of weeding their rows of wheat, before the land has been cleansed by fallow or otherwise ; but this cannot be done whilst any spurious seeds remain in it ; unless weeds had such an antipathy to the drill as the ancients fancied their

herba medica had to iron, so that they might refuse to grow, because the drill had passed over them. But it is so far otherwise, that weeds will not only grow in the rows, but also, if not taken out, receive as much vigour from the hoeing as the corn will.

Having accidentally heard that drills have been made and sent a great way to strangers who are going into this practice, without any experience or knowledge of it, I could think of no better way at present to serve them and others who may do the same, than by giving them these cautions ; and assuring them, that in my opinion, if by any whatever mismanagement they fail of success, the fault will be imputed to the husbandry itself ; though if such mismanagement (contrary to them) should have succeeded, it must have been an argument against the truth of the principles whereon the husbandry is founded. And that it may not be thus unjustly disparaged, nor the well-wishers to it injured by their own rashness, is what has induced me to publish these papers, and my own imperfections, I fear, too precipitately ; on which account I hope the reader will pardon the oversights I may have made, and also some which may seem such, until further explained.

I need not say writing is none of my business ; but I hope the farmer will not regard the roughness of the style, because he knows a plough will go never the better for being polished, though much the cheaper for not being besmeared with dung : yet I must confess that I have much less aversion to dung in the field, than I have to the expense of buying and carrying it thither ; and I do not doubt but many farmers will hate that as much as I do, when they are convinced by their own experience they can go on very well without it.

Here I should be wanting in my duty to the horse-hoeing husbandry, and to those who might successfully practise it,

if I did not take notice of the wrong done to both, by some who, in opposition to these cautions, either of their own heads, or by the instigation of ignorant pretenders (who had no further aim than to get money by imposing on them), bought instruments of those pretenders, and went into practice, in which they were so hasty as to give judgment before my Essay was published, wherein are all my directions ; and the judgment they gave was not against their own rashness, as in justice it ought only, but against my scheme, which they could not perform, unless they had staid till it was published ; for my Chapter of Wheat had never been seen by any mortal till just as it went to the press, which was but a little before they pronounced their judgment, viz., That they had made trial of it, and it did not answer, and they believed it never would answer. The error was in the word *it*, which can be justly applied to no other practice but their own phantasies, yet they expressed themselves in such a manner that the *it* was understood by the hearers as if it had been my scheme, the principles whereof they must have been strangers to, unless they had been conjurors. What their practice was I know nobody that knows, nor perhaps did they themselves know much more of the performance of it than what their bailiffs (whose word in these matters is scarce ever to be relied on) told them : I only know it negatively that it could not be mine.

Their rash practice, and judgment more rash and unique, joined with the common prejudice, which truths that seem new generally meet with, must have been a disparagement to this husbandry.

Besides, the word *answer* is of such a large extent, that though they should have had success in their project, it might not have answered their expectations ; they might not only have expected that weeds should not presume to grow on the land over which the drill had passed, but also that it

should transmute the clods to gold without study or trouble ; that is the only scheme would please them.

They seem to have entered on their project as a trick to get money ; and if they have made it a trick to lose money, what could I have done more to caution them against the rashness of their judgment, and the loss of their money ? And so grateful were they for those cautions, that if the pretenders could have directed them in my scheme, they would have forestalled my Essay ; for what occasion would there have been to publish it, if those pretenders had been masters of it ? But since they have prejudged my scheme, before they knew what it was, I hope they will not disparage it further now it is published, as their conduct is likely to do, if they meddle with it : it is better that they leave their agriculture to be managed at the direction of their bailiffs, who generally know how to deal with such masters.

A gentleman of discretion will, before he gives judgment, or enters upon a large practice, make the index and trials I have herein recommended ; and if among my arguments he finds one demonstration, as I believe he will, for proof of each fundamental principle whereon the scheme is founded, he may be sure it cannot fail of success but by some misapplication or defect in the execution, which he will take care to have rectified in every (necessary) particular ; and then he will see the scheme duly performed. How long a time may be required for him to accomplish this, and to become an expert practiser, will depend upon his conduct and the docibility of his servants.

A gentleman who consults with his bailiff about entering upon a new scheme of husbandry, is likely to have the same encouragement as a Papist having a mind to turn Protestant would have, by asking the opinion of his confessor.

Whoever they are who go into this practice without the forementioned precautions, they ought not to wonder that

they cannot perform it properly, since this is a new scheme, the directions for which are given but from ten or eleven years' practice (in wheat), and written in a language whereof the writer has in a manner lost the idiom, when the old scheme has been described with the greatest eloquence of both dead and living languages, and practised above three thousand years, and there are very many practisers that do not perform it properly yet, as is agreed, I believe, by most writers of agriculture.

But a new scheme, founded upon true principles, though at first it may seem difficult to perform, will become easy when the hands that are to perform it are reconciled to it.

If I had ever advised others to practise this scheme, I could not have been justly accused of insincerity in recommending to them what I did not practise myself; I have not had an acre of sown wheat these nine or ten last years, and have at this time a hundred acres of drilled wheat; all upon wheat-stubble and black oat-stubble, except nineteen acres; and upon the same farm where the tenant used to sow twenty-five of wheat, and rarely could compass to sow thirty; and part of that was generally spoiled by poppies, and the rest not very good.

My 100 acres are all of white-cone wheat drilled in double rows, the partitions, some a foot, some ten inches wide. I have not seen any of it, being confined within doors by many diseases, several of which are adjudged to be the most cruel of any incident to a human body. Therefore having no overseer in whom I can confide, I am not certain how my crop is or may be managed; but it is certain if the principles are not followed, it will not be the scheme; but I hope this will not be so far from it, as that whereon the above-mentioned fallacious equivocal judgment was given, and which has been much more injurious to the true scheme than the Equivocal Society could ever have been; because these are

evidently infamous writers, and of no credit, hired on purpose to cry it down ; but those mal-practisers, or at least some of them, are said, and (which I am sorry to believe) known to be gentlemen. They have indeed by their bare words (though as rash and inconsiderate as their practice) hindered the truths that support the vegetable principles from being brought into a method whereby agriculture might have been treated on more properly as a science ; for every true demonstration is self-evident : I am far from saying all my arguments are such, or any of them, if they had not had the approbation of proper judges ; and now it is upon their judgment more than my own that I depend upon the validity of most of them : and I do not in the least doubt, but that the unexpensive trials I have recommended, being properly made and repeated, will so fully confirm those truths, that no prejudice whatever shall afterwards be strong enough to prevail against them.

Why our moderns (to say no more of the ancients) have treated of the subject very superficially, a reason may be given, viz., Mr. Evelyn wrote no treatise of agriculture, Mr. Laurence was a divine, Mr. Bradley an academic, Dr. Woodward a physician, Mr. Houghton an apothecary ; these for want of practice could not have the true theory : and the writers who are acquainted with the common practice, as Mr. Mortimer, &c. (whether for want of leisure, or not being qualified, I do not know) have said very little of any theory, except such as the author quoted by Equivocus writes, when he recommends the dunging of land with malt. And if regular planting (contrary to random) be the true practice, yet it cannot be practised in great quantities without proper instruments to lessen the human labour of it ; as one drill will regularly plant in very near rows, more land in a day, than fifty men can set, at the same distances and exactness ; and as without the plough very little of the fields can be

tilled, so without the drill as little of them can be regularly planted. Therefore a person must be well acquainted with the practice, theory, and proper instruments, before he can treat of agriculture as a science. But whether he may be the better qualified for that purpose, by being unacquainted with ancient and modern *Treatises de Re Rustica*, the reader may judge.

True principles may be useful to every good scheme of husbandry, as they are absolutely necessary to this of horse-hoeing: but I think no other new scheme has been so much as proposed of late, except that of Mr. Laurence for introducing *assa-fœtida* into our fields into the room of clover and St.-Foin; on what principle that scheme is founded, I am ignorant; yet perhaps it may be as acceptable to some as one founded upon the most approved and truest principles, be it ever so practical, unless it would immediately enrich them, without the study and trouble that are first necessary for their servants to perform it properly: but yet it is probable there may be others of a different way of thinking from these, enough to make the horse-hoeing common in time to come, if not presently; this being in many particulars preferable to the other schemes of regular planting, which at present in many places get ground in reputation beyond the random agriculture.

But when the best scheme once obtains, though it cannot last as long as the truth which supports it, because that is, (like all truths) eternal; yet it may probably last as long as the earth continues to be cultivated by tillage.

The last answer I have to make, and with which I conclude, is to the objection of singularity, and of this I cannot be guilty, if what Equivocus affirms be true, viz., That Platte fell into the same way of thinking, and that his scheme was like mine, which then must have been a sort of vineyard culture; and if Mr. Worlidge or any other fell into

the same way of thinking, when they aimed at contriving an instrument for regular planting, which Equivocus says, was like my drill, I am not singular; for without doubt Platte must have taken his hints from the vineyards as I did; and if Mr. Worlidge or any other had taken their hints for a drill from the organ as I did, they would have saved me a good deal of trouble and expense; and what is more, would have saved me from the misfortune of being an author. I am sure I always like my thoughts best when they agree with other men's, except when reason (according to my notion of it) compels me to think otherwise; and whilst I apprehended them to be singular, I had no design of putting them into writing; but being by irresistible importunities and solicitations pressed to publish my own thoughts upon husbandry, I have done it to the best of my poor abilities, and faithfully.

By what I have said of the rash judgment, I would not be understood to complain of any person's conduct who at any time has made trials of whatever kind, for his own curiosity, with regard to any caution whatsoever: every man having right to lay out his money in what manner and by what advice he pleases; and if thereby a better scheme than mine should be found, I shall be glad of it.

The judgment was given by a few, and of whom, according to my information, only two or three were gentlemen; their names I neither know nor desire to know, but they were enough to raise a report which did the wrong I complained of, and I appeal to their honour (which is inherent to all gentlemen) against that judgment when they are better informed; for I hope no gentleman will persist in a wrong, when he knows it, especially in matters that so nearly concern his country as agriculture doth. The injury done to me, how great soever, is inconsiderable in comparison of the least done to the public; and he that will do any thing for

its service, as I have endeavoured to do, may expect to be a sufferer. If I had refused to say any thing of the horse-hoeing scheme (which my reason and experience convinces me is the best), and had published only my instruments and general principles of agriculture, perhaps I might have suffered less : and whether I had not then gone further in these two articles than any author that has writ on the subject before me, is not proper for me to say, but for the reader to judge.

THE END.

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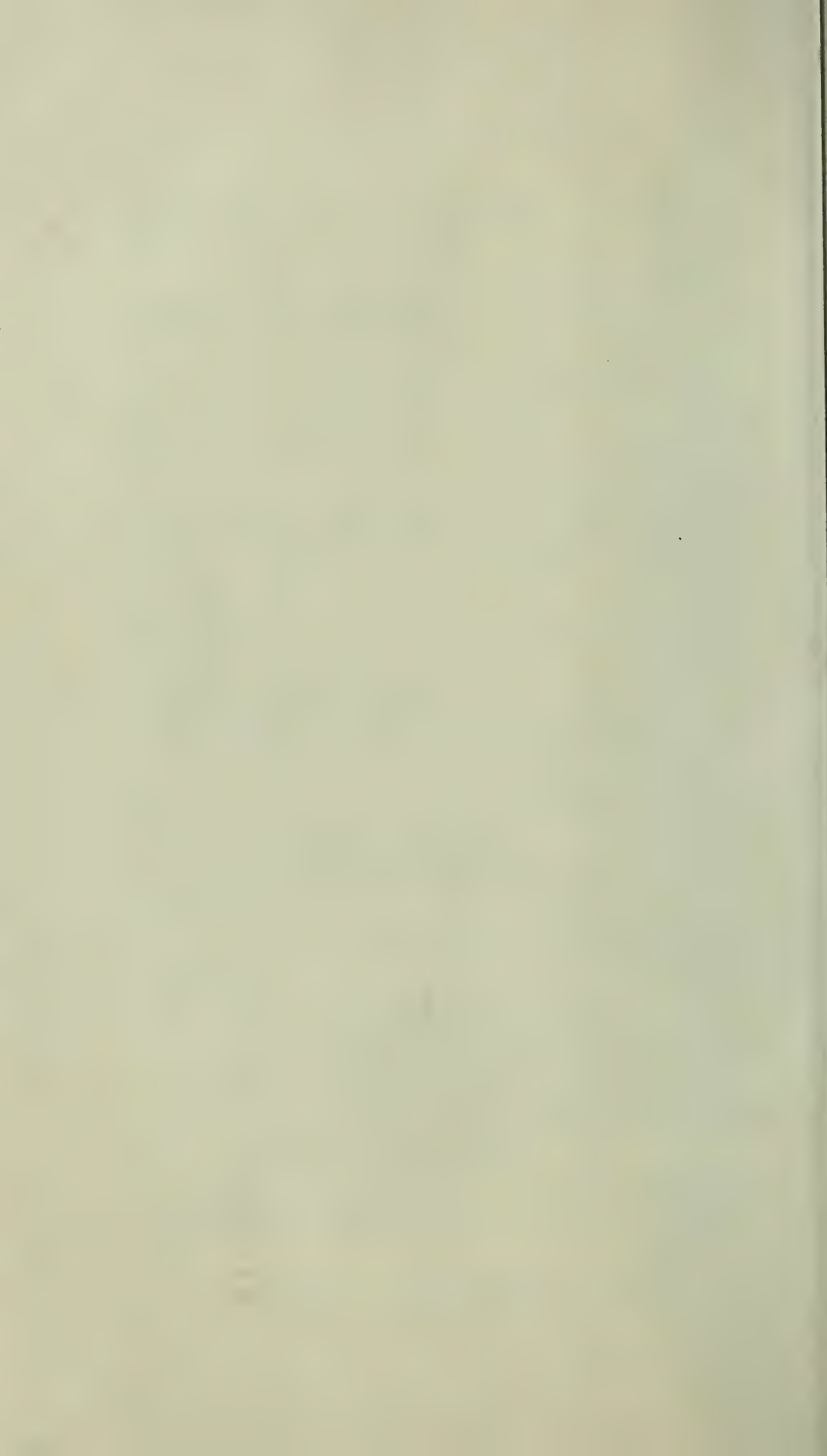
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